PAIGE MARIE PATCHIN
LOVE
IN THE
TIME
OF
ZIKA
ENVIRONMENTAL CRISIS
AND THE
FUTURE OF REPRODUCTION

Love in the Time of Zika

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Environmental Crisis and the Future of Reproduction

PAIGE MARIE PATCHIN

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This one is for Sacha.

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Preface

How should the Zika public health emergency of 2016 be read? Was it a novel convergence of human, mosquito, and viral reproduction, resulting from evolutionary histories both inconceivably long (as in the history of human life on Earth) and extraordinarily compressed (due to the emergence and fast mutation of viruses)? Or was it the reduction of people's lives to their capacity to realize latent danger through the children they might have? Was it the reconstitution of reproduction by turbulent more-than-human worlds as the Earth heats at unprecedented speed? Or an instance of the persistent blaming of women's reproductivity for all manner of social ills, the denial of what Loretta Ross and Rickie Solinger have named "reproductive justice"?[1] How should we conceive of reproduction's natural histories vis-à-vis its social histories? What will reproduction look like as the climate continues to break down, and what *should* it look like?

These are the questions that guide this book, which explores the conversion of people and other forms of life into objects of reproductive management in response to mounting environmental uncertainties. It makes the case that in an age of environmental change of all kinds, reproduction must be read as a dense and planetary process, one that enjoins social, ecological, and evolutionary histories. But that process must also be apprehended as a stratified one: There is still so much to understand about how *power* works in reproduction, for how it works is changing.

While I do not dwell on my own experience in the chapters to come, it would be strange to deny the reader the conditions of this book's gestation. The research began a decade ago, when I began a project on the politics of love. The World Health Organization (WHO) had just declared Zika a public health emergency, and the stories of mothers giving birth to babies with microcephaly in South America, Central America, and the Caribbean were rife. My plan was to go to Puerto Rico to explore Zika's reworking of maternal and family love, and in doing so to contest the dominant style of health reporting in the United States, which subsumed both adults and children there in what Paul Farmer would call a "geography of blame."[2] This was supposed to be just

one part of that wider study on love, but the emergency immediately gripped me. On my journey there in the summer of 2016, the airport security agent greeted me with a warning about the virus and asked if I was pregnant. Zika signs stood out among the ceaseless streams of people; "DON'T LET THIS BAD BUG BITE YOU," they ordered, a monstrous *Aedes aegypti* mosquito bearing down from above, and below, a map dividing the Western Hemisphere into two discrete zones: the Zika-stricken zone and the zone that had, as yet, presumably been spared. All of this blended seamlessly into the rest of the security infrastructure. On my arrival, a Centers for Disease Control and Prevention (CDC) health advisory notice again asked if I was pregnant and informed me that "Zika is linked to birth defects"; another declared, "Protect yourself and your family from Zika." When I called my mom to let her know I'd landed in San Juan, she told me to use "bug juice"—US Marine Corps slang for insect repellent—and to think about my future self. It would be hard to overstate the extent to which I was, from the start, hailed as a Zika subject, my body a potential vessel through which the virus's dystopic horizons could be actualized. And as that subject, I turned my full attention to the virus, setting out to understand how various public health interventions were working in Puerto Rico and to reflect on their consequences.

In the following years the research would expand outward from the Puerto Rican archipelago to form an expansive map—of treetop scientific observatories in colonial Uganda, of factories producing novel genetically modified insects in Brazil, of commercial health databases that have no identifiable place, to name a few. After I started working at University College London, once home to the Galton Laboratory of National Eugenics, I would key the story of Zika into an expansive genealogy of reproductive thought on evolution, eugenics, extinction, and much besides.

This preface is an opportunity to declare something that I will elaborate gradually throughout the account to come: The way we think about reproduction has consequences far beyond those which we tend to associate with the reproductive processes of sex, gestation, birth, and early infant care. So when I ask how the Zika emergency should be read, from the vantage point of global concern now having washed away as quickly as it swelled, I can offer a promissory note of a response here: It should be read as something much more than what it was. The rise and fall of the emergency is a kind of test case for reproduction's futures as the Earth heats up, what Sally Falk Moore would call a "diagnostic event."[3] My diagnosis includes the rising tide of racist and fascist discourses of reproductive control and environmental crises as being caused by baby-making, as well as the proliferation of means through

which the meaning of human life is being emptied out of every area but the economic. We ignore these various scripts of climate crisis as a reproductive panic that is unevenly distributed across the planet at our peril, for they threaten to extend and escalate in the years to come.

This is also a chance for me to be unequivocal about my intentions from the outset. The book should not be taken as an effort to diminish the danger of Zika or the suffering it has caused. Microcephaly, the condition the virus sometimes produces in babies, is extremely painful, both for those it affects and for their caregivers, and that pain explains at least in part why the virus ignited so much fear across the globe in 2016. However, it is my hope that two positions can be held at once: (1) that public health concerns that can cause impairment must not be denied and care cannot be rationed or withheld; and (2) that illness and disability—as well as the body simply not functioning as you wish it to—are all central aspects of being human.[4] I think carefully about the permeation of Zika's reproductive matrix with eugenics in what follows, especially in depictions of some future children as divesting from the fates of others. This means holding on to the tension between Zika as a serious public health threat and Zika as a licensing maneuver with all sorts of cruel roots and outcomes—often through the lexicon of love for children. So in the end, it appears I haven't abandoned those difficult questions about love after all. I try to hold on to them in what follows.

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INTRODUCTION
Reproduction Redux

In a factory in Campinas, in the state of São Paulo, Brazil, mosquitoes are reproducing. Within the white walls of the facility set among warehouses, there are breeding cages that are buzzing sites of *Aedes aegypti* sex, and there are breeding trays in which eggs become larvae then pupae then adults. From the contact paper at the bottom of each cage of thousands of specimens, technicians harvest eggs and dry them out for days, sometimes weeks. The desiccated eggs are measured out by weight into trays and mixed with a splash of water and a dose of the antibiotic tetracycline. They hatch and, nourished by fish food, grow into swimming pupae. Technicians plunge the wriggly mass of pupae under a wire mesh. As they swim up in pursuit of air, the females, slightly more rotund, drown, while the males pass through to the surface: This is how they are selected by sex. The male pupae are stored in small plastic containers, about a thousand of them in each, as they continue to develop.

A van filled with the plastic tubs of male mosquitoes leaves the factory in the early hours for Piracicaba, a city about an hour's drive away. It circulates slowly through the neighborhoods. Every few minutes, a scientist in the back

of the van grabs one of the containers, opens it, and empties it out into a funnel cut through the window, a portal to the outside. A shake and a tap ensure that all the male *Aedes aegypti* are unleashed into the morning air. They become part of the city, entering the single-story houses that line the streets and flitting around human passersby, in search of female mosquitoes with which to mate. This cycle, from dry egg to natatory pupa to sexually mature, airborne urban male took a little more than a week, and it continued on repeat across a four-year period, in which an untold number of mosquitoes were bred and then released.[1]

The longstanding dream of Western public health has been to expunge *Aedes aegypti* from the face of the Earth. In the mid-twentieth century, military-style chemical fumigation campaigns nearly succeeded in eradicating the insect from twenty Latin American countries, including Brazil.[2] Why, a little more than fifty years later, were they being produced in a factory and let loose into Piracicaba? Why was mosquito reproduction being promoted instead of repressed?

One answer to this question is that the mosquitoes being churned out of the factory were a different sort of mosquito than the kind that would normally meet the wrath of your slapping hand. They were patented products, made possible by recent advances in the life sciences. Created by the British biotech firm Oxitec and marketed as "Friendly™ Aedes" (*Aedes do Bem*™ in Portuguese), their genomes were distinct. Inserted into the Friendly Aedes were regulatory genes from the common fruit fly, as well as activator genes from the common viral infection herpes simplex and genes from the mushroom coral that make the mosquito's belly shine red under fluorescent light. Genes from the cabbage looper moth were used as a carrier to introduce all of this extant DNA.[3] But what really defined the Friendly was the tTAV gene, borrowed from *Escherichia coli* (*E. coli*), which programs for offspring death. When released through the funnel in that van, Oxitec males set off to mate with wild females, and their tTAV genes ensured that their children would die before reaching sexual maturity. By successfully competing with wild males in copulating with wild females, and producing offspring with lethal genes, the masses of Friendly mosquitoes released in this ordinary Brazilian city succeeded in dramatically reducing the number of *Aedes* in the area. Mosquito reproduction here fulfilled its purpose through mosquito death, disturbing the assumed equivalence of reproduction and life.

A longer answer is the problem on which this book focuses: the Zika virus, which caused a global public health emergency that imperiled love, sex, pregnancy, childbirth, and the future—an emergency, I argue, that crystal-

lizes how reproduction is changing in the twenty-first century and impels a reappraisal of the idea of reproduction altogether.

The story of the Zika emergency began in earnest in the spring of 2015, when mosquito engineering in Campinas was in its infancy. (On the discovery of the Zika virus in the mid-twentieth century, see chapter 1.) Brazilian health officials noted the presence of the virus in the northeastern part of the country and, months later, reported an explosion in cases of microcephaly in human offspring: The number of babies born with small head size had multiplied by twenty. As Zika found its way into neighboring countries and then threatened to edge up into the United States, researchers rushed to ascertain the link between it and microcephaly. They reached two points of consensus. The first was that Zika could be transmitted by sexual intercourse and by the *Aedes aegypti* and *Aedes albopictus* mosquitoes, making it the first virus with both of these transmission mechanisms. The second was that when contracted during pregnancy, especially during the first trimester, Zika could severely impact fetal development. A mosquito-borne, sexually transmitted disease with a definite link to children's disability had emerged. In February 2016, in only the fourth such declaration in its history, the World Health Organization (WHO) named Zika a public health emergency of international concern.

Early on, Zika drew comparisons to another ongoing public health emergency of international concern, the West African Ebola epidemic (2013–16). Yet, despite the mortality rate of that strain of Ebola reaching 60 percent, WHO official Bruce Aylward stated that Zika was "much more insidious, cunning, and evil."[4] Such "quasi-theological tones," which Kevin Bardosh argues saturated the early global response, positioned reproduction at the heart of the meaning of human life, centering the vulnerability of babies to microcephaly and the women who gave birth to them—or could, or might.[5] Government and healthcare officials strove to mitigate the circulation of the virus through chance contact with the mosquito's proboscis or in the exchange of bodily fluids during sex, testing out all sorts of ways of regulating reproduction.

By way of introduction, let's consider just one. Under the sign of Zika's new and terrifying powers, the government of El Salvador exhorted its citizens to refrain from having children for a period of two years, a recommendation that the vice minister of health felt "obligated to make."[6] This official, blanket urging of a moratorium on procreation, reduced-duration versions of which other governments announced, was in many ways unprecedented. It was also issued in a context of high rates of sexual violence, limited access to contraception, speculation that Zika was being utilized as a Trojan horse for curbing popu-

lation growth, and a ban on abortion that carries a prison sentence of up to fifty years. This call for nonreproduction cannot be separated from persistent moralizing about female sexuality or from the history of institutions, from the hospital to the reservation to the plantation to the church, promoting, forcing, or precluding reproduction. That women's and girls' bodies have long been understood as a key site where the kinds and qualities of life could be politically shaped has translated into reordering and controlling their lives—often exposing them to premature death in the process.[7]

Yet Oxitec's intervention into the reproductive cycle of the mosquito, which in the years that followed would crescendo to the mass production of mosquito eggs for shipment worldwide, was another effort to regulate reproduction in the time of Zika. The emergency raised the profile and market value of the Friendly mosquitoes' deathly liaisons with wild females, bringing *Aedes* reproduction into collision with human reproduction and viral replication the world over.[8] *Aedes* were just one part of a dense network of reproductive relations that extended beyond the sexed human body and its political and cultural meanings and restrictions. The emergency conformed to leading climate-change scientists' predictions of fecund viral futures, emanating from expanding torrid zones, in which the reproductive pathways of both disease-bearing mosquitoes and dangerous viruses multiply and thicken. Further, it added to speculation about human extinction—or, stated differently, the end of human reproduction—in the midst of a broad ongoing extinction event caused by human activities. The plea for people to stop having children hinted at the ineluctable place of human reproduction within nonhuman worlds and histories. The asexual replication of the Zika virus, its movement between mosquitoes and human bodies, and its capacity to shape the human fetus are together exemplary of reproduction's charged and changing relationship with environmental uncertainty in the twenty-first century. The emergency's reproductive forms, each in its own way, speak to the gathering and building planetary crises of environment. They speak, in other words, to the changing shape of reproduction in what has come to be understood as the Anthropocene.

In her delineation of the concept of "distributed reproduction," Michelle Murphy has offered that reproduction "does reside in bodies, and lives become precarious in birth and pregnancy. But"—she asks—"does reproduction stop there?"[9] The Zika emergency, with its explicit recasting of both virus and mosquito as reproductive agents that threaten human fetuses and children, shows us that reproduction surely does not stop there: All were children of the Anthropocene. But how it does not, and why it does not, matters.

The opening contention of this book is that Zika, as global health crisis and as cultural object, is indicative of both the sustained grip of late nineteenth- and early twentieth-century understandings of reproduction on medicine, culture, and politics—which I will go on to describe as the *modern reproductive imagination*—and the future of reproductive politics in an age of environmental breakdown. To borrow from Raymond Williams, we find in the recent history of Zika dominant meanings, practices, and values concerning reproduction that have been in place for a long time, and we also find emergent ones that are enfolded in and constitutive of a planetary geography of environmental uncertainty.[10] Some of these emergent forms might actually be oppositional to dominant cultures, pointing to substantively alternative ways of thinking about, and doing, reproduction. Many of them, though, are simply new expressions of the dominant. Reproduction might be changing, yet the narration of those changes, and the principal responses to them thus far, recuperate and reproduce the main templates of dominant modern reproductive thought, namely, (1) the premise that human reproduction is an ideal site of social and ecological engineering for both public and private institutions, (2) the positioning of the sexed female body as the central point of intervention, and (3) the promise that both utopian and dystopian futures can be realized through reproductive tinkering.

If the virus's sudden imposition of an unruly nonhuman world on the human fetus and child evinced the entwinement of viral, human, and animal reproduction on a heating planet, the public health emergency that followed evinced the stratifications, abandonments, and life curtailments at work in today's reproductive politics more generally. Such inequality is shown, for a start, by the episodic nature of the emergency itself: Global interest in Zika disappeared just as precipitously as it rose. In November 2016, the WHO revoked Zika's status as a public health emergency of international concern on the basis that the "extraordinary cluster of microcephaly and other neurological disorders" which defined the virus's ascent in global awareness had not been sustained or replicated in other countries as the months went on. "Intense action" would still be required, but the emergency label no longer applied; instead, a "longer-term technical mechanism" was needed for managing the circulation of Zika and its suite of consequences.[11] For other global health agencies, Zika's recession from emergency consciousness was even more abrupt. The Pan American Health Organization, for example, denoted Zika a "neglected, tropical, and vector borne disease," bringing it into the collection of "forgotten" infectious diseases "that primarily affect the most vulnerable populations."[12]

This book explores the range of futures people were seen to encompass, and the range of interventions into their bodies that were realized in the name of future children, during Zika's brief period of cultural and scientific ascendency. Building on the work of geographer Becky Mansfield, it shows that in Zika's reproductive network, some women and girls (racialized, poor) in some places (the "tropics," the "territories," and others outside the overdeveloped world) were positioned as the threshold between nature's increasingly aberrant fertility and a future of limited wealth, and accordingly, subjected to intervention.[13] It postulates that this logic—which I call *thresholding*—will become increasingly clear, common, and harmful for the people at its center in years to come. Throughout, it demonstrates the sustained financialization of future life and eugenics amid climate crisis, and the persistent marking out of deserving from undeserving future children. Determinations, comparisons, and linkages of reproductive worth are a central feature of life under environmental breakdown.

In the remainder of this introduction, I trace a rough history of the modern idea of reproduction, from its formulation around the idea of social engineering, to its more recent shift to the grammar of economy, and on to its present-day reconfigurations through both advances in the life sciences and environmental crisis. Zika will appear at key moments in this history, showcasing how the emergency drew on the modern reproductive imagination as well as calling into question the ground on which that imagination stands.

Through the insights into Zika and the response to it that then emerge, I intend to suggest that modern reproductive thought—pressured by but ultimately able to absorb new environmental factors—continually makes two key distinctions, two cuts into humanity. It marks off the free, and therefore properly human, reproductive subject from the reproductive object. And it positions the fully human child as a surrogate for the future, endangered by the economic and ecologic drain on resources effected by another kind of child. These distinctions animated damaging and unethical policies and interventions across the Zika emergency, which would be resisted at every turn but which also stimulated some other ways of thinking about reproduction. My premise is not only that alternative conceptions of reproduction can and are being generated; it is also that perhaps they point us in the direction of a different kind of understanding of living together while temperatures, sea levels, and walls rise.

The Modern Reproductive Imagination

The use of the word *reproduction* to describe the making of new organisms, including human babies, is relatively new. Before this use was inaugurated by the French naturalist Georges-Louis Leclerc in 1749, debate about the coming into being of organisms (from immaculate beginnings, it sometimes seemed) turned on the concept of generation. How did generation work? Why did it happen? And was its origin male or female? These were the kinds of questions being posed. Chinese explorations of organism generation, for example, focalized the energy cascades of different networks of organs in male and female bodies.[14] In the West, Aristotle's influential proposition was that "bloodless" animals like insects were generated without any input (that is, spontaneously), while the generation of others, like humans, hinged on sex. His view that the female progenitor supplied, through menstrual blood, the matter for generation, while the male progenitor's semen gave that matter its human form, was replicated in Judeo-Christian and Islamic understandings of semen as baby-making's central ingredient.[15] For example, René Descartes, that famous theorist who wrote on the mind-body dualism while being cared for by others, described how semen "is fermented and cooked together by maternal heat, its parts entering a subtler mixture."[16]

The concept of reproduction, by contrast, had from the start connotations beyond the body and its organs and fluids. That Adam Smith had used it as a label for how economic value could be created and re-created demonstrates a link with the concept of production, but when Leclerc applied it to the making of new organisms, he named "a process of maintaining a species in time, a process that perpetuates the stability of form in organisms across generations."[17] Whether in moneymaking or in baby-making, the reproductive process was effected through the labor of work or birth and, reflecting the wider European project of cataloging and delineating plants, animals, and racial types that had been in motion since the sixteenth century, it was tied up with the concept of the species. Nick Hopwood finds the idea that there was a distinct shift "from a broader, premodern framework, 'generation,' to the more abstract, modern notion of 'reproduction'" a bit simplistic but nonetheless sees "much truth" in it.[18] By the eighteenth century, reproduction was taken to mean a stable process of re-creating species uniformity that enjoined the individual bodies carrying it out.[19]

Things started to change in the nineteenth century. Reproductive cells were distinguished from the other cells of the body, and a complementarity between egg and sperm, on which the sexual reproductive process hinged, was

first articulated. Perhaps more importantly, speculation that the appearance, disappearance, and reappearance of different qualities and features across generations occurred through a biologically discernable process emerged and provoked experimentation in several areas in the 1850s. One was large-scale agriculture, in which selective breeding programs of animals like sheep provided clues about the transmission of characteristics from parent to offspring. At the same time, it became fashionable for physicians in France to scrutinize the family trees of aristocrats to understand predispositions to certain illnesses.[20] The consolidation of the idea of inheritance in reproduction coincided with its dissolution in the realms of property ownership and monarchical power: Following the French Revolution, the traditional meaning of heredity was submitted to scrutiny both legal and philosophical.[21] Meanwhile, on the plantation, J. Marion Sims was conducting horrific medical experiments on enslaved women to develop the science of gynecology, and slaveholders were looking to reproduction as "expanded property-holdings" and "a form of speculative value."[22] By the late 1870s, the idea of reproduction had begun to harden around two things: heredity, or vertical biological transmission from parent to offspring, a notion recently migrated from religion and law to biology, and the image of the fusion of egg and sperm, which was observable under a microscope for the first time.

Charles Darwin didn't understand inheritance. (He mistakenly thought it worked through a blending of the traits of each parent.) Nor was he the first person to propose the concept of evolution. (Circulating in the middle of the nineteenth century was the idea of many parallel lines of biological development for each species; in this "pluralist" conception of evolution, different races each had their own origin and pathway to development, making white and Black people different species.) But it was his work, and the scientific and practical interventions it would go on to inspire in the ensuing decades, that was most impactful in the construction of the modern reproductive imagination. Darwin's early education included the socialization that came from being from a wealthy family of abolitionists and interacting with race science's worlds of skull comparison and phrenology as a medical student in Edinburgh. On his famous trip around the world on the *Beagle*, a vessel tasked with charting the South American coast for the British Empire, he collected a lot of samples; he also recorded horrified reflections about the slave societies and extermination campaigns he encountered. *On the Origin of Species* was released in 1859 and immediately made a splash, making the case that all life-forms shared a common ancestor and that, over the long stretch of evolutionary time, species evolve.[23]

Reproduction was key to these incendiary contentions. The book argued that life evolved through the competitive process of natural selection: "Fitter" organisms were more likely not only to survive, but to reproduce, producing viable offspring that would go on to reproduce themselves. Three elements of this argument sit at the center of the modern reproductive imagination. First, it hinged on the distinction between sexual reproduction and the mere duplication that defined other modes of reproduction. Jean Baudrillard has written that sexual reproduction, with its recombination of biological material, is a more advanced mode of reproduction than the replication of bacteria or viruses: "The resulting entity is no longer a copy of either one of the pair that engendered it; rather, it is a new and singular combination. There is a shift from pure and simple reproduction to procreation: the first two will die for the first time, and the third for the first time will be born. We reach the stage of beings that are sexed, differentiated, and mortal."[24] This is variation and differentiation. They remain with us today in *Merriam-Webster Dictionary*'s definition of reproduction, which includes "subsequent growth and differentiation into a new individual."[25]

The second element was population growth, or the propensity toward reproductive plenitude. Here, the influence of economist and demographer Thomas Malthus, active a half century earlier, is apparent in *Origin*'s stated aim of exploring the drive, universal and ceaseless, to procreate: Darwin wrote in his introduction about wanting to understand the "struggle for existence among all organic beings throughout the world, which inevitably follows from their high geometric ratio of their increase," later adding, "there is no exception to the rule that every organic being naturally increases at so high a rate that if not destroyed, the earth would soon be covered by the progeny of a single pair."[26] The flip side of this propensity was the possibility of reproductive cessation, or extinction, a concept that Darwin developed through correspondence with the geologist Charles Lyell to denote that less fit types would disappear across evolutionary time. Through a failure to compete to reproduce, types would die out. And, provocatively, so could entire species.

This final element of *Origin*'s contribution to the modern reproductive imagination—extinction—represented a significant divergence from the idea that the universe was conceived perfectly by God. Nothing could be subtracted from it through the cessation of reproduction.[27] By contrast, evolution indicated a world in flux, constantly being remade through the accumulation of reproductive acts over time. This unstable, open world meant consequences for not only those species that could disappear from the face of the Earth, but also for those with enduring reproduction: As Murphy argues,

"reproduction as an evolutionary process did not simply maintain species-kind but instead produced the difference that natural selection sorted."[28] It did not simply replicate life as it always was and always would be, but instead created differences, variations, only some of which would survive to themselves reproduce.

But what did all of this mean for the social life of humans? One person who tried to answer that question was Francis Galton, Darwin's cousin, who after reading *Origin* began to think about variation in domestic animal breeding and the survival of the fittest together. His 1869 book *Hereditary Genius* brought that analysis to bear on human development.[29] Darwin tried too: *The Descent of Man*, published in 1871, was his long-awaited commentary on human evolutionary development, where he made his case for the common origin of humanity explicit, tried to account for racial difference, and developed the theory of sexual selection as a subset of natural selection. Sexual selection operated through the tastes and choices of individuals—women, principally—and would actually shape the kind of human character and temperament that would live on in different populations.[30] Through reproduction, the futures of different peoples, races, and nations, and humanity writ large, could be shaped.

A few additional discoveries thickened the proposition that the composition of humanity could be intervened in via the reproductive process. In the 1890s, German biologist August Weismann further developed the idea of inheritance, outlining reproduction as the transmission of "the heritable essence of an organism . . . through sexual recombination, from one generation to the next."[31] Soon thereafter, the famous pea breeding experiments of the Austrian monk Gregor Mendel, which a half century earlier had posited a stable, particulate hereditary material, were rediscovered; Mendelianism "offered the possibility that the simple numerical ratios discovered in plants would be found in animals, and by extension, in the human species."[32] Genetics and evolutionary biology emerged as realms of professionalized science and expanded rapidly in the decades that followed, and they joined eugenics, the applied science devised by Galton that harnessed knowledge around inheritance toward "better breeding" (the word borrowed from the Greek *eugenes*, meaning "well-born"). Eugenics sought to improve nations, races, and species, either by coaxing "fit" groups or individuals to reproduce or by precluding "unfit" groups and individuals from reproducing. Apprehensions about racial and national futures became bound to fears of disability in a broad framework that surveilled, institutionalized, deported, sterilized, and euthanized women (and some men too).[33] There was an assuredness, too, that "inferior" races were fated to be-

come extinct over time, so that the benevolence of the "superior race" consisted of assisting them along that pathway.[34] By the early twentieth century, human reproduction had become an area of active technocratic intervention that focused on the sexed female body.

It wasn't only sexually mature bodies that occupied the heart of the modern reproductive imagination. Also there, gleaming as evidence of both the benefits of eugenicist improvement and the dangers of degeneration, and as both reproductive outcome and proto-reproductive subject, was the figure of the child. Carolyn Steedman has shown that the modern idea of the child and evolutionary biology emerged together in this period. The proper process of embryonic growth in utero, outlined by physiologists, mirrored proper progression of evolutionary forms. The child's physiological development was yoked to the development of the human species across time, a yoking that would help position human reproduction as a major focus for governments concerned with the biological composition of their populations. Out of the circulation of scientific knowledge on child development between experts and publics, the child emerged as a chronicle of the great biological past of humans as well as, crucially, a receptacle of a specific inheritance that would shape the future.[35] For this reason Rebekah Sheldon argues that children "exited the nineteenth century as the nexus point coordinating life, species, and reproduction with history, race, and nation."[36]

That nexus point was as practical as it was conceptual. Children would go on to star as the emblem of the future in eugenics programs, with both disability and racial degeneration lurking as palpable threats: "polluting the gene pool, or weakening the nation, or destroying a family's quality of life, or draining public services (or, often, some combination of the four)."[37] Note the links between children's degeneracy and the composition of future populations here: The modern reproductive imagination positioned these children as injurious to the future, and not just as a general problem but as a specific one that threatened the well-being of others, both children and adults, in the future. These understandings of child life cannot be filed away as part of a hideous past. Both the terms *degeneration* and *defect* were used throughout the Zika emergency: the former to describe the brainstem and neural cells in babies with microcephaly, the latter as shorthand for microcephaly itself. Even though, as I will go on to explain, microcephaly was the result of forces outside the body instead of a genetic condition, it was still effectuated by a kind of vertical passing down from mother to child during gestation, and the figure of the disabled "Zika baby" was the abject—the repugnant, the threatening—against which other children and their futures were defined.

Anchored in the new worlds of evolutionary biology, the modern reproductive imagination brought together sexual complementarity and recombination, vertical transmission from parent to offspring, the drive to reproductive abundance, and the previously unthinkable possibility of extinction. Concerns over degeneration emerged among imperial nations in competition with one another, preparing the ground for the main premise of interventionism. Earlier expressions of this premise can, of course, be found throughout the history of empire, particularly on the plantation. But the instantiation of the idea that the *wider social world* should be manipulated through reproduction is what I am interested in, as well as how this constellation of ideas around reproduction started to organize knowledge more broadly. We see a swelling of concern for infant health and motherhood practices in the early twentieth century, for instance, along with investments in education and public hygiene and the emergent science of statistics also situated in reproductive thought.[38]

I am also interested in the fact that the capacious interest in reproduction in science and governance was not matched in philosophy. Questions about what reproduction is and how to do it might have figured centrally into questions about human life and its purposes and values, if the people that were the modern reproductive imagination's central objects had been allowed space to think and write their place in the world. They weren't. One of this book's aims is to examine this gulf, both experiential and interpretive, between the social engineering of reproduction and those positioned as objects of that engineering.

Economies of Reproduction

None of these dynamics have remained unchanged. Understandings of and approaches to reproduction shifted in the latter half of the twentieth century, as overt race science gave way to different framings of future life. Michelle Murphy argues that a new logic emerged during the Cold War, when experiments in family planning became the dominant form of managing reproduction in place of the obligations of pregnancy or sterilization found in eugenic protocols. Fetuses, girls, and women—as well as the children they *could* have in the future—were classified by their projected impact on economies. "A new era of calculative practices designated both valuable and unvaluable human lives: lives worth living, lives worth not dying, lives worthy of investment, and lives not worth being born," Murphy writes. She terms this the "economization of life."[39]

The designation of valuable versus unvaluable future lives meant that reproductive interventions were not so much concerned with individuals as with an aggregate would-be life that could be assessed in the lexicon of cash. The approach pivoted on the notion that some people must not be born so that others might live more affluently in the future. In this way, it can loosely be traced back to the central tenets of both Darwin and Malthus: There are always too many organisms that are reproduced, so some organisms must die without reproducing in order for other (fitter) organisms to live. The major question asked in their "biological-spatial" conceptions of reproduction was this: "In local, national, and global human ecology, which humans died (or would ideally be prevented from being conceived in the first place) to make room for the rest?"[40] The economization of life tracks this question back in time, before birth, and forward to the future through a vocabulary of collective prosperity (or at the very least, stability), focalizing uteruses as the collective progenitor of future economic life, and therefore as sites of economic governance.

In practice, this meant that more and more development-oriented reproductive health programs were assembled with the ambition of cultivating future prosperity, and as Kalpana Wilson agues, they often mobilized feminist conceptions of choice.[41] These programs were authored and funded by governments, to be sure, but as we get into the twenty-first century, increasingly by large philanthrocapitalist organizations. Take the Bill & Melinda Gates Foundation (BMGF, now the Gates Foundation): With an endowment of USD $40 billion at the height of the emergency, which has more than doubled since then, it is the most powerful philanthropic organization in the world. Its influence in the WHO is particularly revealing: Providing 10 percent of the WHO's total budget, the BMGF has over time succeeded in moving the organization away from the task of bolstering national and community health systems and toward vertical technological fixes.[42] Its signature and highly influential initiative, Family Planning 2020 (FP2020), brought the foundation together with the UK Department for International Development, the United Nations Population Fund, and the US Agency for International Development to monitor the activities of governments and nongovernmental organizations (NGOs) toward the goal of "contraception acceleration." FP2020's language is one of female empowerment, and its promotional material is explicit in denouncing eugenic pasts. However, its aim of adding about 120 million new users of "modern contraception" across the Global South ("120 by 20") positions their fertility not only as an urgent problem but as a counterpoint to material comfort.[43] The BMGF has become a fundamental executor of the phi-

losophy of economic governance via the reproductive body—and, as we will see, played a prominent role in reproductive interventions and innovations during the Zika public health emergency, from fast contraceptive implant insertion drives to the manipulation of mosquito genomes.

Here is a striking example of the economization of life's general principle of reducing the not-yet-born but could-be-born to economy that is central to our story: Not long after Zika was named an emergency, experts priced a single case of microcephaly at USD $10 million or more across a lifetime.[44] This figure, which included direct medical costs and broad societal productivity losses, was soon repeated in medical and government circles and reported in major media, making the Zika crisis not only an issue of public health but also one of economy. Health, wellness, and economics flickered in and out of focus as government officials, scientists, and philanthrocapitalists expressed the urgency of "averting," in the language of Murphy, cases of microcephaly. Rapid family planning programs funded by the US Centers for Disease Control and Prevention (CDC), the BMGF, and various pharmaceutical multinationals were rolled out with the objective of birth aversion, which blurred with broad desires to protect the deserving children of the future from being undermined by the costs that would amass around babies with Zika-associated microcephaly.

While it is clear that the reproductive health projects of the late twentieth and early twenty-first centuries were distinct from earlier forms of population control, the turn from the biological framework of heritability to the framework of future economic potential has not entailed the full displacement of the former. This is true even within imperial hubs like the United Kingdom and the United States. The oeuvre of Dorothy Roberts is key to grasping this play between the philosophy of race and disability engineering and the now-dominant language of choice and financial prosperity in reproductive health, and between the state management of genetics at the population level and the individual management of one's genetic code in reproduction.

Roberts's first book, *Killing the Black Body: Race, Reproduction, and the Meaning of Liberty* (1997), examined the US government's longstanding assault on the reproductive capacities of Black women. In doing so, it contrasted policies that discipline poor women of color for having children, because those children are costly in the eyes of the state, with advanced biotechnologies that facilitate financially advantaged, usually white, women in their endeavor to gestate genetically related children. For context, the latter part of this juxtaposition showcases the dramatic transformation of reproduction by advances in molecular biology and genetics across the last few decades. Melinda Cooper has documented the rupture of the modern reproductive imagi-

nation by the invention of genetic engineering, which enabled the creation of beings like the Oxitec mosquitoes.[45] Indeed, it is now not unusual for fertilization and early embryo development to occur outside the body, while a $2 billion surrogacy industry enables wealthy consumers to have genetically related children through the labor of others. A new cluster of fertility scientists, specialists, and therapists wield unprecedented control over the various stages of human reproduction, with prenatal screening allowing for the termination of pregnancy based on the genetic conditions of an embryo, the selection of a favored genetic makeup for children, or germ-line editing.[46] On the one hand, these transformations have dethroned the sexed female body from its position as "our species' sole child-delivery system," dispersing reproduction across many bodies and places through cash exchange and institutional change.[47] On the other, they have strangely reaffirmed the modern understanding of reproduction as the transmission of genetic essence: Reflecting what Lara Choksey calls the "cult power of genomics," wealthy would-be parents think readily of genetic risk and optimization as key factors in their reproductive decision-making.[48] Thus, we might add the *optimization* of life to Murphy's economization of life as a key stream of reproductive thought and intervention in the latter part of the twentieth century and the early part of the twenty-first.

In more recent work, Roberts has reconsidered her antagonistic framing oppposing one reproductive regime that punishes poor women of color for having children with one that promises wealthy consumers, through biotechnology, children with ideal genetic profiles. She now sees these approaches as linked in consequential ways.[49] With Sujatha Jesudason, she shows how women are now broadly expected to regulate their reproductive conduct in conversation with their genetic inheritance, which could, when mixed with that of another, produce children with disabilities. That expectation, they argue, "may fall especially harshly on Black and Latina women, who are stereotypically defined as hyperfertile and lacking the capacity for self-control."[50] The thesis is that it is not necessarily elite and middle-class women who are more likely to undergo prenatal screening for genetic or congenital abnormalities, but rather impoverished women of color, because they are encouraged—or obliged—to do so in a broader institutional environment that deems disabled children, children of women of color, children of immigrant women, and children of poor women to be a societal drain. Economization and optimization work in tandem, the former put in service of the latter.

This dynamic returns us to the matter of children. Lee Edelman has argued that an all-pervasive image of future children (which he stylizes with delib-

erate capitalization as "the Child") serves, coercively, as "the telos of the social order." Distinct from "the lived experiences of any historical children," the Child is the figure without which we cannot conjure the future (despite the future entailing the denial of rights, resources, and care to the adults some children go on to become).[51] Ironically, the image of the Child devalues the real experience and value of childhood. This is because the future always recedes: Though we are obliged to act in its name, "it never comes; the horizon shifts and what matters is the next generation child, and the next, and so on."[52] In contrast, real children have value in the present. On this point, I am moved by the writing of the nineteenth-century Russian philosopher Alexander Herzen, who, when trying to come to grips with his son's death, defended the significance of his short life even though it did not bear any fruit in adult achievements: "Because children grow up, we think a child's purpose is to grow up. But a child's purpose is to be a child. Nature doesn't disdain what only lives for a day. It pours the whole of itself into each moment. . . . Life's bounty is in its flow. Later is too late."[53]

Though Edelman presents "reproductive futurism" as a transhistorical feature of public life, from the examples he develops I interpret the reduction of the future to symbolic children to be a recent phenomenon, which joins in our genealogy of reproductive thought that first began to configure a relationship between the child and the future in the nineteenth century. Reproductive futurism was certainly evident in early presentations of the Zika virus (that is, during the emergency, when it was projected to spread and shape fetuses and children everywhere): One epidemiologist proposed that Zika imperiled "love, sex, and babies . . . the foundation of human existence";[54] a religious philosopher surmised that it touched on "primordial—one could even say ingrained—anxieties: that invisible forces threaten the health of our children, the survival of our families, by extension the human species."[55] But despite the distinction he makes between the symbolic child and living children, Edelman misses the racial and geographical determinants of reproductive futurism. While it may be impossible to inveigh against the Child (as symbol and symbolic beneficiary of the future), inveighing against the living immigrant child or living disabled child is a well-worn path that evicts some kids from the kingdom of the future.[56] As chapter 1 will show, a line has been drawn between children with microcephaly and children to be invested in, with an adversarial relationship being set up between them bit by bit.

Indeed, there was a general transition in the way Zika was talked about as the months passed, from the symbolic child, a proxy for the future, as potential victim of the virus, to the real child as actual victim of the virus, which

constituted, in its own victimhood, a financial threat to the symbolic child. The public health emergency as a whole overlaid the modern reproductive imagination's calculations about degeneration with the language of reproductive cost. Longstanding eugenicist logics joined up with relatively new modes of calculating the cost of future life that were made to seem agnostic in terms of race and nation. But despite the general appeal to the meaning of life and the future of the human species, coupled with the vernacular of monetary value, race and nation were never far from Zika's matrix of reproduction.

Reproduction in the Anthropocene

So far we have tracked the assembly of a modern reproductive imagination from the advent of evolutionary and eugenicist thought to its economization and onward to its recent reorganizations by advancements in the life sciences. But where is reproduction now, as debates are increasingly viewed through the prism of ecological ruin, as popular culture speculates in the same moment about crises of overpopulation and infertility, and as we reckon with the incontrovertible position of human reproduction within nonhuman reproductive forms? What, in other words, is the state of reproduction in the Anthropocene?

The Anthropocene as Planetary Conjuncture

As a technical term, the concept of the Anthropocene came into regular use in 2000 after chemist Paul Crutzen and marine scientist Eugene Stoermer proposed a new geological epoch following the Holocene, defined by the "central role [played by] mankind in geology and ecology," which Crutzen would go on to elaborate in an influential piece in *Nature* in 2002.[57] At the risk of abbreviating much, the Anthropocene thesis is that, whether by the burning of fossil fuels, the march of technological advancement, or our sheer force of numbers, *people* have shaped the planet—detrimentally, indelibly, and on a geological scale. The nine candidates that the interdisciplinary research collective Anthropocene Working Group recently proposed as sites that best demonstrate the scale of human alteration capture the breadth of the thesis: From an ice core in the Antarctic Peninsula to a peat bog in the mountains of Poland, "signals"—microplastics, pesticides, radioactive isotopes, and ash from the combustion of fossil fuels, among others—have been trapped in the strata of the Earth, while two of the proposed sites, the West Flower Garden Bank in the Gulf of Mexico and Flinders Reef off the coast of Australia, comprise "living golden spikes" as coral exoskeletons ensnare toxic particles

in layers as they grow.[58] (The threatened use of the pesticide Naled as a Zika control mechanism, described in chapter 2, is especially resonant at these two sites, for it is known to be noxious to corals.)[59] As an umbrella term, *the Anthropocene* thus captures structural transformations of the planet and life on it as species extinctions accelerate. It has become a touchstone for all sorts of debates (scientific, political, aesthetic, moral), not only about the origins of climate crisis, multiplying forms of environmental turbulence, and potential future courses of action, but also about the perennial problem of how to define human life vis-à-vis nature. Rosi Braidotti writes, "The Anthropocene entails not only the critique of species supremacy—the rule of Anthropos—but also the parameters that used to define it."[60]

Scholars writing in Marxist and postcolonial traditions have taken issue with the way the Anthropocene thesis casts humanity as a single, uniform agent. Dipesh Chakrabarty was one of the first to contest its flattening language, asking why climate crisis would be attributed to humanity in general instead of to rich nations, rich classes, or economic systems, while Andreas Malm and Alf Hornborg argued that climate crisis is "sociogenic" instead of anthropogenic. And a number of alternative appellations—Capitalocene, Plantationocene—have sought to bring various power relations into the frame.[61] These writers seek to apprehend the Anthropocene in its historical fullness, insisting on the inextricability of the making of the modern world by colonialism and capitalism and the reconfiguring of the Earth by climate change. They creatively hold standpoints from the Anthropocene and from Indigenous genocide, the slave plantation system, and European overdevelopment in concert, thinking "simultaneously through historical periods and geological epochs, in time scales of centuries and across multimillennial spans."[62] And they do so in full view of the philosophical distinction between natural and social history—common in the West by the seventeenth century, dominant by the nineteenth—having melted away.

This melting has demanded a methodological promiscuity of sorts. Climate breakdown has meant that tried-and-tested tools for making sense of modernity are both radically necessary and radically insufficient. Of his own awareness of this, Chakrabarty narrates, "As the crisis gathered momentum in the last few years, I realized that all my readings in theories of globalization, Marxist analysis of capital, subaltern studies, and postcolonial criticism over the last twenty-five years . . . had not really prepared me for making sense of this planetary conjuncture within which humanity finds itself today."[63] Perhaps it is the case that our current predicament obliges the generative integration of what Chakrabarty calls "the human-existential category of power and its

sociological-institutional correlates" with newer kinds of materialisms that are alert to a vast realm of nonhuman or posthuman activity, from the atmosphere that envelops our planet all the way down to the molecular activity of viruses like Zika.[64] Ian Baucom has recently taken up this project in his search for a method befitting both the history of racism and capitalism and the projected four-degree rise in global temperatures that climate breakdown portends. Working with Claude Lévi-Strauss, he argues that understanding life in the Anthropocene requires thinking both "beneath" and "above" history. In this approach, things like the functioning and firing of neurons ("beneath") and carbon cycles, orbital wobbles, and tectonic plate movements ("above") resolutely *are* history and must be taken seriously as such.[65]

What would it mean to go beneath history and approach the Zika virus itself genealogically, instead of accepting it as a transcendental object that maintains a constancy throughout history? Looking at something like a virus in this way is tricky: As Ian Hacking has noted of tuberculosis, "only the most irresponsibly playful of writers (plus some fools who ape the playful) would assert that TB bacilli, or their baleful effects on humans, came into existence in 1882 under the gaze of Wilhelm Koch."[66] His point is that tuberculosis has an existence that is at least partially independent of human interpretation. But while Zika certainly has a history that preexists its isolation and naming by colonial health officials, which I narrate in chapter 1, the virus does not course through history in a simple sameness. Instead it has changed (mutated), as have the mosquitoes that carry it. Zika's recent evolutionary history must be analyzed along with its domains of knowledge, politics, and culture. Doing so requires rethinking scale and resituating human life and politics in the incomprehensible reaches of geological and evolutionary time.

Reproduction Under Environmental Breakdown

I have learned much from these theorists of climate, and the persistent intercourse in their work between Earth history and world history, between planet-centered and human-centered thought, and between historical and new materialisms ("Materialisms I and II" in Baucom's formulation) informs the analysis to come. But I have been struck by their general lack of engagement with sex and gender and, both more specifically and more broadly, with human reproduction—including its history (is it social or natural?), its role in looming environmental crises of all kinds, and its value for imagining new worlds. Suspending for just a moment that immense world of reproduction that exists beyond human life, which I will get to shortly, applying Baucom's beneath/above approach to human reproduction already opens up some fasci-

nating lines of flight. Beneath history, you've got the twists and turns of reproductive cells in motion, including the ineluctably agentic egg, which despite its recurrent framing as a "damsel in distress, shielded only by her sacred garments" in biology textbooks, harnesses its inner vestments to draw in and trap the sperm.[67] You've also got the brutal parasitism of the fetus—itself replete with parasites—which, in Sophie Lewis's reading of recent scientific work on human gestation, is even more rapacious than the parasitism of nonhuman fetuses.[68] Above history—where Lévi-Strauss refers to "the general evolution of organized beings," and where Chakrabarty points to the fact that evolutionary chronologies "run through our bodies and lives" even as they flounder in aligning with our internal sense of time—you get into reproduction's central role in the constitution of the human species on Earth.[69]

Note that, in this sense, reproduction is one of the few areas in which, long before the recent casting of humanity as a geological agent in the naming of the Anthropocene, Western thinkers have considered human life as part of a deep history, as the history of evolutionary thought attests. (Race-thinking is another closely related area.[70]) Note also that thinking about this need not necessarily lead us down the stream of social Darwinist and eugenicist thought running through the modern reproductive imagination. The work of creative thinkers like Pyotr Kropotkin and Dorothy Dinnerstein speaks to anti-essentialist understandings of human nature across evolutionary time. Kropotkin, an early twentieth-century theorist of revolution and evolution, looked to the animal world to theorize the role of mutual aid, showing that life shaped by evolution was much more than a violent struggle for reproduction and much more complex than endless domination across generations. Dinnerstein, working as a psychoanalyst in the mid-twentieth century, suggested that while distinct gender roles in reproduction did arise from evolutionary forces pressing down on early human life, resulting in particularly constrained lives for birthing people, these roles are not written in stone. Nothing in evolution is. That's the point. There may indeed be deep evolutionary roots to the modern reproductive imagination's collapsing of reproduction onto people coded as women, but the fact remains that reproductive arrangements are emphatically mutable. Her view was not only that prescriptive gender roles in the human reproductive process have outgrown their adaptive function (and may, in fact, bring about the destruction of the human species), but also that a key aspect of humanity, developed across evolutionary time, was the capacity to tinker with and change modes of social organization—including how we do reproduction.

Where there has been engagement in the question of reproduction in the age of the Anthropocene, it has focused on the matter of population; that is,

the number of humans on a dying planet as that number bears on the dying. The history of this debate is much longer than the denomination of our new geological epoch, tracking along the development of the modern reproductive imagination across the twentieth century: In the period of ascendent eugenics, population linked the fertility of land with the fertility of women in questions of racial and national futures, while in the second half of the century, it was positioned as an exploding "bomb" that would overwhelm the planet.[71] But public discussion about human population bloomed anew as anthropogenic climate change became a matter of shared identification and concern in the opening decades of the twenty-first century. We hear, for instance, Prince William talking about "overpopulation in Africa" at a wildlife conservation event, we see the mainstreaming of the position that the best way to combat climate change is to have fewer children, and we record a new environmentalist frame for the bounteous aid money flowing from various sources to family planning programs to curtail reproduction in the Global South. Contravening commonplace complaints that any discussion of population is taboo, baby-making is consistently being cast as a central driver of climate change.

These examples should not be taken as evidence of an exhaustive global remonstrance against reproduction in the last two decades. At the same time as contraception and abortion are being newly scripted as solutions to global environmental problems, so too is access to them being newly restricted. The overturning of *Roe v. Wade* in the United States, the circulation of the "Great Replacement" thesis, Italy's recent declaration of a national emergency over its falling birth rate, and the instantiation of selective pronatalist policies from China to Iran to Hungary speak to the eminently variable landscape of reproduction in the Anthropocene as fascist sentiments simmer and surge. What *is* clear is that the politics of reproduction are changing as the Earth changes, and there is a flourishing discourse of human *non*reproduction that sees human reproduction as an expansive and transhistorical procreative drive that threatens nature, but one that can and should be interrupted through careful planning.

It's a premise that is increasingly being tested out in scholarly circles, too. Most famously, Donna Haraway's *Staying with the Trouble: Making Kin in the Chthulucene* (2016) set out the ambition of bringing human population, in a numerical sense, into the purview of left feminism: The projected "9 billion increase of human beings over 150 years," she argues, is "not just a number."[72] Despite my work being quite obviously influenced by her creative approach to science as "cultural practice and practical culture,"[73] I am one of the many who disagree with her proposed reinvention of population-thinking, taking

issue with the naming of a number and the banishment from the field of analysis of uneven landscapes of production, consumption, and state violence. In the intervening years that reinvention has been contested by those working in Black feminist and Indigenous feminist traditions, such as Ruha Benjamin and Kim Tallbear, as well as by Jade Sasser and many others whose examinations of family planning programs expose the "dehumanized 'thingness' of population."[74]

These tussles are far from being settled. In fact, the new shapes and faces of questions about human population might indicate a shift in assumptions about right and left politics or point to synergies between the liberal and the fascist. Such questions are alive in this book, where the Zika emergency reveals how the philosophy and management of population are shifting under emergent and uneven environmental pressures. For example, I show how reproductive interventions that preclude births are increasingly overlaid with climatic forces—which are never purely climatic—that displace people from their homes and homelands. The politics of population are not limited to the number of people on the planet or in a particular region, nor the population-thinking of family planning programs; they are also about the depopulating currents of climate change and the abandonment of social reproductive infrastructures. But crucially, I do not contain the scope of these questions to human population per se. It is a matter to which I return in the epilogue, but the intervening chapters take their time, en route, in unraveling the nexus of environment and reproduction from a range of other perspectives that both capture the present of environmental crisis and hint at its futures.

Vital to our discussion is this fact: The bond between reproduction and life has become unsteady under climate breakdown. The modern reproductive imagination focalized the giving or making of life, instantiating the idea that life could (and should) be controlled, shaped, or optimized at the site of the reproductive body, while recent technological advancements have further enhanced the capacity to optimize, squaring with both the medicalization of aging and the rise of elite health-based consumptive cultures seeking to extend life across the overdeveloped world. Already we have had cause to question this correspondence between reproduction and life, or at least to see it as something particular rather than universal: The underbelly of the dominant conception of women as progenitors of life in the modern reproductive imagination, after all, is the ascription to them of the potential for negative impact over life, and therefore, deaths of all kinds.[75] Yet something else is going on in environmental breakdown, a deeper transformation of reproduction whereby the weakening of life, and indeed even death itself, has become

a main feature. As Rebekah Sheldon has argued, extinction, exhaustion, and enervation mark contemporary reproductive politics as much as enhancement and extension do.[76]

There are three senses in which this devitalization of reproduction is so. First, just as signals of the Anthropocene in the form of chemicals or particles accrete in land, sea, and layers of the Earth, so too do they accrete in the human body, and it is their detection in the *reproductive* body that tends to sound a particularly loud alarm. The concern is not so much for the present contamination that this accretion exemplifies, but for the attenuated constitution of future human life it threatens. Mansfield shows that guidance for pregnant women on seafood consumption spatializes their bodies as the threshold between a wider polluted environment and future population health. In urging them to modulate fish consumption, such guidance reduces pollution, a problem that is both ubiquitous and uneven, to one of individual conduct, yoking a weakened future to the women's present actions.[77] How environmental contamination's connections to industrial practices are remapped as fully under the remit of women's choices requires explanation, which chapter 2 undertakes by examining chemical-based Zika management. Here, dovetailing with the "new emphasis on permeability and plasticity during fetal development" in the life sciences,[78] it is enough to say that the wayward particles of the Anthropocene increasingly scan as having the potential to enfeeble human life in and through reproductive processes.

Next, concern about the future of human life is enveloped in a reproductive redistribution, both documented and projected, in which some modes of reproducing and some species wither, while others proliferate. Here, the sixth mass extinction of the Anthropocene could be narrated as an overtaking of the sexual reproduction that defines the modern reproductive imagination by other ways of making more biological matter. "Large branches of the tree of life that produce unique genetic individuals through fixed modes of heterosexual reproduction" have been obliterated by humans; asexual reproduction and other forms of symbiont transmission, such as those practiced by the Zika virus, flourish.[79] If Baudrillard's argument that the asexual order of viruses enabled the higher order of sexual reproduction did at one point hold true, it appears that environmental upheaval has begun to suggest a reversal of sorts, in which nonsexual forms of reproduction—or, to revive the eighteenth-century term, *generation*—overtake the sexual as the dominant form. (The singular individuals produced through genetic recombination in sexual reproduction have actually always constituted a small percentage of life-forms on the planet, making this more of a threatened reapportionment

than a reversal, but the point stands.) It is also the case, as we shall see, that even within the realm of sexual reproduction there is a reapportionment unfolding: a "biological annihilation" of a great many species, including extinctions and general species declines, simultaneous with the expansion of a few, including those that adapt well to heat and are well integrated with modern human life, like raccoons, cockroaches, and mosquitoes.[80] As just one illustration, the *Los Angeles Times* has reported that hotter weather prolongs the reproductive seasons of rats and other rodents, growing their populations in sprawling metropolises and rendering the people there vulnerable to bubonic plague.[81] This is not a straightforward efflorescence of those species that have, in the words of the authors of one study, an "admittedly bad reputation": In fact, one-third of parasitic species, which play a fundamental role in all sorts of ecological webs, are predicted to go extinct by 2070.[82] However, in what Colin Carlson and his team describe as a global parasitic "redistribution," the reach and reproductive pathways of some undesirable species—like *Aedes*—have expanded dramatically.[83] Reproduction in the Anthropocene is asymmetric, with some life-forms becoming hyperfertile or reproducing too much, with unforeseeable consequences for human life.

Building on this (as well as returning to the matter of human population in a roundabout way), suggestions abound in our historical moment that the technoscientific optimization of human life for some now proceeds under the portent of the *end* of human life in the teeth of climate breakdown. Alongside the proliferating apocalyptic stories of human extinction in print and on screen, for example, it has become commonplace to suggest that a human reproductive crisis is on the horizon, on the basis of a documented dramatic drop in sperm concentration. The numbers are stark: A 2017 study found that sperm counts in the overdeveloped world had halved in the last forty years, while another in 2022 confirmed drops of a similar magnitude in Africa, Asia, and Central and South America.[84] One of the researchers, Shanna Swan, has published a full book on the matter, which is clear in its diagnosis of Anthropocene signals like plastics and pesticides as fundamental elements of a global fertility demise. GQ narrated her work through both vertical familial descent and species atrophy: "We are half as fertile as our grandfathers were. And if the trend continues, we may very well reach a point where the human race is unable to reproduce itself"; *Newsweek* reported that this fertility demise could "spell the end of humanity"; the BBC, that it "could make humans extinct."[85] A collective scientific and aesthetic imaginary has begun to solidify around an increasingly disobedient nature which, having been degraded and defiled by Anthropos, will settle the score in reproduction.

A Primer on the Anthropocene, Reproduction, and Zika

What are we to make of the unsettling of the covenant between reproduction and life in the Anthropocene, and of its planetary compendium of reproductive reshufflings? As a start into this question, let's consider some of the ways the Anthropocene, as both a material reality (oceans surging, mosquito populations expanding, winds becoming more powerful, temperatures ascending) and an idea, manifested in the Zika public health emergency. In the first instance, following Baucom's approach, this investigation means sitting inside nonhuman reproduction *as reproduction*. We are already partway there when we consider the epidemiological concept of "basic reproductive rate." At first glance, this is a technical formula in which the transmission coefficient of a viral agent (the average number of susceptible people that one case infects per unit of time) and the average length of time of infectiousness are multiplied in order to estimate the number of further cases of a virus to be generated by a single one. Stripped back, though, the concept reveals the number of human bodies in which a viral agent will replicate on the back of that agent already having replicated inside one human body (which also explains its historical antecedents at the nexus of concerns over population growth and the practice of immigration control).[86] That is to say, it captures infection as reproductive act and reproductive process.

Viruses like Zika are one of the most plentiful things on Earth and "fundamental players in the history of life."[87] They are defined by their need for the machinery of others (plants, animals, humans) to reproduce, reconfiguring their host organisms in the process. Zika's main mosquito carrier, *Aedes aegypti*, is also a reproductive protagonist in its own right, whose mode of sexual reproduction, so smoothly imbricated with urban human society, prompted *National Geographic* to affix the label of "the most dangerous nonhuman animal on the planet" onto its elegant striped abdomen.[88] These intricacies of viral replication and mosquito reproduction, thoroughly interleaved with those of human reproduction, are analyzed by various methods as historical, rather than assumed or backgrounded, across the chapters that follow. Here, it is their positioning in the turbulent worlds of climate change that is worth highlighting, and the point is twofold. The first concerns speed: The reproductive cycles of both are much faster than the unfolding of human lifetimes. This is especially the case for the virus: In what immunologists call the "generation gap," viruses reproduce a half million times faster than humans. Fast reproduction means dynamic viruses whose shape and capacity change at every turn. For example, it is now thought that the Zika emergency was set in motion by a single genetic mutation, which rendered the virus capa-

ble of changing the methylation of human genes engaged in fetal immune response and neural development.[89] Defining processes of the Anthropocene, such as deforestation and the replacement of diverse ecosystems with monocultures, have smoothed over and streamlined the reproductive progression through which a viral mutation could become a viral epidemic.[90] The second concerns heat, the influence of which contributes to speeding up and complexifying diffusion courses for new and mutated diseases and to the expansion of the geography of so-called tropical mosquitoes like *Aedes*. Mosquito reproduction pathways multiply—resulting in more "life-cycle completions" of *Aedes aegypti* per any given location—which means that the replication pathways for mosquito-borne viruses multiply.[91] In these senses, climate crisis has been pivotal to the larger range of *Aedes aegypti* mosquitoes and to Zika's transformation from a virus that was generally innocuous until the 2010s, into one that could shape fetal neurological and musculoskeletal matter on a large scale. Or, in simpler terms, global heating amplified viral and mosquito reproduction to the detriment of human reproduction.

Can these natural histories of reproductive life, both protracted and condensed, be interpreted together with human history, politics, and culture? Just as it is imperative not to view humanity as an "undifferentiated whole"[92] (despite there being something important and meaningful about universal humanity), not all viruses have historically registered as public health emergencies (despite the centrality of viral reproduction to all other life-forms, including all human life). One reason Zika, as well as H1N1, Ebola, and COVID-19, did register as emergencies is that that they threatened to jump geography and cast risks beyond the borders of the areas where they first mutated or jumped species. Bruce Braun importantly argues that the contemporary politics of health is defined not only by the cultures of individual genetic risk management and optimization, such as through the moneyed reproductive decision-making I discussed earlier, but also by the risks people in privileged social locations feel in connection to a global field of microbial chaos. Imaginations of this chaos—long assumed to emanate from outside the overdeveloped world or to be attached to certain racial groups within it—have intensified amid what Alan Ingram calls the "radical dissolution of epidemiological space" in the twenty-first century.[93] "For every story in the US media that speaks breathlessly of advances in stem cell research and gene therapy, or that worries over the 'post-human' futures these might usher into being," Braun writes, "we find two or three other stories that speak ominously of migrating birds and backyard chickens, and that mix together Vietnamese peas-

ants, influenza viruses and homeland security."[94] A similar argument can be made about reproduction in the Anthropocene more generally, for the global, racialized field of microbial chaos invoked here was also taken as a global field of errant nonhuman reproduction.

Such divisive biosecurity imaginations were evident in science and media reporting on Zika. Early in 2016, in an influential piece in the *New England Journal of Medicine*, Anthony Fauci and David Morens mapped "the explosive pandemic of Zika virus infection occurring throughout South America, Central America, and the Caribbean" as "potentially threatening the United States."[95] When active Zika transmission was first reported in Florida, reporting focused on microcephaly as a shocking potential outcome for children in the United States that was made possible by a mosquito and a virus which had no place there. Discussions about the permeability of borders and aggregate financial speculation were churned up with those on expanding mosquito populations, the winds and rains of tropical climates goading on their reproduction, the sexual practices of people in Brazilian favelas, and the precarious procreative futures of North American honeymooners. In this mix, one image reigned: the underdeveloped craniums of children born with microcephaly, those Zika babies there threatening the child here. "When I saw the first picture of a baby with microcephaly, I burst into tears. It seemed so far away in the jungle, and then it was in my backyard," one pregnant woman stated in a long-form piece in the *Miami Herald*.[96] Reproduction in the overdeveloped world was perceived to be under threat from the over-reproduction of viral and mosquito forms in the tropical world—and in its racialized human forms, as I have already begun to explain. Across the months that followed, the possible futures of fetuses and children were positioned in antagonistic relation to one another in health and in wealth. Practically speaking, women and girls were understood, and intervened in, as if their bodies were thresholds between present circulations of Zika and economic futures. They were called upon to behave responsibly in sexual relations and in relations with mosquitoes in order not to become host organisms for Zika, and when perceived to fail, their bodies were obtruded in in all sorts of ways. Creative technical intercessions into mosquito sex expounded on these dynamics. The nonhuman reproductive politics of climate change return us, perhaps paradoxically, to the uneven *human* geographies of race, empire, and patriarchy, to a picture, riffing on Matt Sparke and Dimitar Anguelov, of inequality of reproductive incrimination and intervention amid a broad reproductive interdependency.[97] This is what all the chapters of this book explore in their own way.

Zika Cultures and Interventions

I must be clear that in narrating the explorations to follow, I do not aim to supply any concrete or practical solutions to Zika. The book makes use of the movement and transformation of the virus to critically reflect but proposes nothing by way of swiftness. While it draws on my reflections from four months in the Caribbean, it is not an ethnography. Instead, it is a philosophical proposition and a history of Zika, though neither an exhaustive nor a chronological one. (The chapters' respective forays into the philosophy and politics of reproduction do, however, build sequentially.) It is both documentarian and imaginative: documentarian, in that I show how various twenty-first-century styles of reproductive intervention work and point to their dehumanizing features and synergies with fascist thought; imaginative, in that I reach toward new understandings of reproduction.

Chapter 1 describes the making of Zika into a public health emergency, beginning with the identification of the virus in East Africa in the mid-twentieth century and following it to the first outbreak in the Pacific Islands in the twenty-first, before delving into popular and medical culture in the United States as the number of cases in South and Central America and the Caribbean grew. It shows how Zika was constructed as a threat to love, sex, and the human species, both through the capacity of the virus and virus-bearing mosquitoes to malform babies as well as through the lexicon of cost. Constructing the emergency in this way, with tropical nature as an amorphous source of danger and microcephaly as a tragic and costly outcome, public and medical culture set the scene for the reproductive interventions that are examined in the following three chapters. I argue that not one but two future child archetypes starred in the story of Zika, and they were constituted by racial and geographical location. One child, who was synonymous with the future amid environmental change, required protection from Zika, while the other, the Zika baby, was a figure of fear about degeneracy. The healthcare costs that would accrue to the latter child were seen to compromise the future of the former. The chapter thus begins to chart an emergent biopolitics which, embedded in and invigorated by ecological uncertainty, pits the possible futures of fetuses against one another.

The next part of the book proceeds with the contention that the necessarily planetary nature of questions about the politics and ethics of reproduction today can only be taken on through the specific historical experiences of the colony or postcolony. Here, I explore how Zika protocol actually worked in Puerto Rico, a Caribbean island with high levels of active viral transmission

during the emergency and one of the world's most climate-vulnerable areas based on peak streamflow estimates from hurricanes.[98] As Jamaican physicist Michael Taylor has argued, the data point to "the climate of the Caribbean region . . . already changing in ways that seem to signal the emergence of a new climate regime."[99] Moreover, to be located in the "Atlantic Hurricane Basin" is also to be located in the Black Atlantic, where life and landscape bear the marks of genocide and plantation slavery.[100] The increased incidence and intensity of extreme weather in the Caribbean, exemplified by the force of Hurricane Maria in 2017, is one example of the life-destroying nature of anthropogenic climate change tracking along the same map as the life-destroying nature of European colonialism, making its inhabitants perhaps some of "the first truly 'Anthropocene' people—the avatars of a fully globe-encompassing climate-changed world to come."[101] Puerto Rico's unique and more recent history as an "unincorporated territory" (read: colony) of the United States added an additional dynamic to the apprehension of the reproductive cycles of mosquitoes and the reproductive rates of the virus as they intersected with female reproductivity in financial and state surveillance terms. The archipelago's tropical position led to predictions that a significant proportion of the population would contract Zika by the end of 2016;[102] its geopolitical mapping meant abundant circulations of people between the Caribbean and United States, unfettered by border control. The former entailed heat and *Aedes aegypti*; the latter revolved around US citizenship rights, including various means of impacting US economic and health futures. These geographies overlapped in designating the reproductive conduct of Puerto Rican women and girls as risky and costly in public health expertise, focalizing their bodies as the principal point of intervention in public health practice, and speculatively linking those interventions to the financialized US child.

I look at two Zika intervention techniques in particular: synthetic chemicals used to obliterate mosquito reproduction and contraceptive devices for implantation inside people's bodies. These approaches appeared officially in scientific reports, intervention plans, and lawsuits, and unofficially in the crossing out and amendments of text in public health notices by passersby, speculations about covert fumigations uttered over the radio, women's nods on social media to having been refused the removal of contraceptives, and the persistent injunction for girls to wear insect repellent "like perfume." Puerto Rican women and girls were positioned as the bodily threshold between the hyperfertile emergency and the deserving and undeserving children of the future: inside the United States in terms of future reproductive risk but outside the United States in terms of reproductive and political rights.

Chapter 2 looks at US government chemical-based mosquito control at the scales of the sexed body, the home, and the island. When Puerto Rican women were perceived to fail in properly maintaining the separation of their bodies and homes from mosquito reproduction, aerial chemical fumigation was threatened in an aggressive display of US sovereign power. Resistance to aerial chemical fumigation, however, offers clues for resituating human reproduction in the material world, as well as for approaching the multiple temporalities of the Anthropocene's "chemical signatures."[103] This chapter continues along the track of peeling away at the normative biomedical scope of reproductive health to develop a conceptualization of reproduction as a system that is viral, animal, and chemical. In doing so, it critically shows that this system is structured by, and constitutive of, various human historical hierarchies.

Chapter 3 examines the mass distribution of contraceptive implants in Puerto Rico during the Zika emergency as an expression of modernity's long-standing translation of human life into speculative economic value that is ramping up in the twenty-first century. The Zika Contraceptive Access Network (Z-CAN), a public-private partnership, sought to equip women with long-acting reversible contraceptives (LARCs) like the intrauterine device (IUD) as a cost-effective way to avert the costs of microcephaly. The program importantly provided people with a contraceptive method of their choice for free but, as I show, came at the cost of reproductive autonomy in unexpected ways. Z-CAN worked by cleaving off the reproductive body (the body involved in what Sophie Lewis calls "gestational labor"[104]) from the body that sustains the more general reproduction of human life. This cleaving must be understood in the context of both Hurricane Maria and austerity. The chapter further articulates the pitfalls of centering the uterus as the singular site of life-making or life-precluding, marking out a path for thought and politics away from the reduction of reproductive women's lives to the children they may or may not have and away from the conversion of would-be children to economic value.

Because this part of the book concentrates on reproductive management as organized and orchestrated by the US government, transnational pharmaceutical firms, and philanthropic organizations, it does leave out much. It only dips a toe, for example, into the ways Puerto Rican government agencies attended to the dangers of the virus, and because it spotlights the way Zika interventions grouped women and girls into a reproductive mass, it runs the risk of flattening the differences of experience among them. But this is, at least in part, the point: I am interested in exploring the production of reproductive masses; I am trying to document and analyze the conversion of life into

reproductive objects to be managed as a response to environmental uncertainty. How Zika and fertility in Puerto Rico were apprehended by states and organizations has much to teach us about the changing shape of reproductive governance under climate breakdown. Furthermore, the tracking of the consequences of those changes along historical lines that predate the denomination of the Anthropocene and the responses of ordinary people to them suggest some creative ways of thinking about and doing reproduction differently.

Shifting the approach, chapter 4 moves to Brazil to discuss three genetic engineering projects funded by the BMGF that were proposed or carried out in the effort to reduce Zika's reproduction rate and avert the outcome of microcephaly. Here we return to Oxitec's *Aedes do Bem*™, those genetically modified mosquitoes whose unleashing in a normal neighborhood opened this introduction. The chapter examines this project's love stories in detail along with two others that programmed *Aedes aegypti* reproduction for death instead of life: one that infected *Aedes aegypti* with a bacterium that transforms the reproductive capabilities of its host organisms, and another that used gene drive technology to push a genetic change throughout a population of *Aedes aegypti* as it reproduces. I consider the possibility that experiments like these, which "play" with reproduction, can aid in dismantling the modern reproductive imagination: Modified mosquitoes certainly exemplify the mutability of the reproductive process as well as our understandings of it. However, in contravening the contingencies of sexual reproduction by compelling a certain gene to be passed along, and in courting the idea of deliberate species extinction in the middle of the sixth mass extinction, these projects rehabilitate the early twentieth-century racial thought that sits at the center of the modern reproductive imagination and elaborate on, via the unsuspecting medium of the insect genome, the eugenic dynamics I have been tracking throughout.

These are all preliminary sketches, of course. But it bears repeating that my motivation for writing this book is as much due to the *implications* of reproductive thought for the most pressing questions facing humanity today as to the prospect of changing the mechanics of reproduction itself. I pick up this point again in the epilogue, which is not to be missed. Reproduction, as Murphy argues, does not "stop" at pregnancy and childbirth and early childcare; it does not "stop" at the "larger structural conditions" that enfold those embodied human experiences, nor at the "smaller micrological entities" inside the body, like recombined DNA and doubling cells, that make them possible.[105] It is, instead, about the making-more of living matter, comprising a profuse and proliferative network of relations reaching far beyond the edges of the sexed human body. I am arguing for its relevance to wider questions

about what it means to be people living among other people and people living among other beings. This requires understanding how the politics of reproduction is changing under the diverse planet-centered and human-centered pressures of our time. And the story of the Zika emergency provides us with an abundance of leads.

1

TWO CHILDREN
Zika's Public and Medical Cultures in the United States

To reproduce, Zika's proteins talk to receptors on the cells of humans and mosquitoes, using the machinery within these cells in order to enter and then make Zika proteins and RNA. A new generation of Zika progeny virions (the complete, infective form of the virus) follows. From its entry point in the human dermis and epidermis, Zika moves to the lymph nodes, producing an immune reaction; it then enters the bloodstream, which affords it access to the rest of the body. All the while it continues to replicate. Human hosts are unlikely to notice this chain of reproductive events unfolding: In the majority of cases, the virus is asymptomatic, and if symptoms do occur, they tend to be very mild. A rash might develop on the skin, or a slight fever may emerge; joints might ache, and eyes might itch. After a week, however, the person will return to feeling normal. With symptoms akin to the common cold or flu, Zika replication in the human body is difficult to detect.

The virus's command of that body is vast, making a home of blood, cerebral fluid, semen, vaginal fluid, and breast milk. In fact, long after becoming undetectable in blood, it can linger upward of sixty days in semen.[1] There, Zika finds its second most-common mode of transmission: human sex. Its primary

mode, however, is the *Aedes aegypti* mosquito, whose geography spans tropical and subtropical regions of the world. *Aedes* thrives in and around the refuse of urban landscapes: discarded bottle caps, the cozy rims of automobile tires, and stagnant pools of all sorts. Her affinity for standing water means an affinity for neighborhoods with inadequate sewage systems, uneven pavement, and dwellings without air-conditioning or screen barriers. Enmeshed in the everyday life of humans, she is profoundly resilient.

Aedes has her own way of doing reproduction. She might mate only once in her life, an act from which she is able to store sperm inside her body and recruit them for later rounds of fertilization. She might lay her eggs in water accumulating in potholes, old tires, buckets, pots, and vessels. Or she might lay a batch in a safe, dry place, where it will wait patiently for rain to nourish growth later. If *Aedes* does not meet any potent insecticides, she will do this perhaps five or six times across her month on Earth and, while she consumes plants from time to time, her quest to mate is mostly nourished by human blood.

> [She] homes in on you by sensing the proximity of blood from your sweat, your breath, your warmth. Her feeding apparatus, that elaborate proboscis, is a multipart marvel with a skin-piercing fascicle of tiny stylets that can suck your blood while injecting mosquito saliva laced with an anticoagulant. A mosquito can slip that fascicle into your skin so gently that you have no idea what's happening until the blood meal is already under way. She can sip your blood until she's more than twice her weight and has to lumber off someplace to rest, jettisoning the liquid and retaining the nutrients, before she can fly properly again.[2]

In a particularly sumptuous blood meal, she will feast on three or four people. My sustained gendering of the mosquito here is deliberate: Only female mosquitoes bite humans, doing so to fuel the reproductive process. In fact, they have been shown to find pregnant humans a twice as attractive source of blood meals.[3] *She* is "the source of human peril."[4]

These are the basic and interlocking mechanics of reproduction underlying the Zika public health emergency. It is through the blood meal that the Zika virus usually finds its way into a pregnant human body; the blood meal yokes the asexual reproduction of the virus to the sexual reproduction of the mosquito to the physiological development of the fetus.

The biography of the virus itself, however, began decades before the genetic mutation that produced a twenty-first century crisis of global proportions. The story begins with the reproductive cycle of mosquitoes unfolding

on repeat in containers on a 120-foot-tall steel tower in a forested region of British-occupied Uganda in the mid-twentieth century. The tower had been constructed by the Rockefeller Foundation, a historical precursor to the Gates Foundation, formed in 1913, which leveraged capital to enable people to live healthy and—this is key—productive lives.[5] Following the discovery that yellow fever was transmitted by mosquitoes and a successful eradication program in Mexico, the foundation sought new field sites for the study of the deadly virus, and one of these sites, the Yellow Fever Research Institute, was established in the Zika Forest: sixty-two acres of thick vegetation and swampland near a Catholic mission, about fifteen miles from Kampala. The word *ziika* in Luganda means "overgrown."[6]

The institute's leadership team, including entomologist Alexander Haddow from the University of Glasgow, virologist George W. A. Dick from the National Institute for Medical Research in London, and Stuart Kitchen from the Rockefeller Institute, constructed the towering structure from which mosquitoes, as well as birds and bats, could be studied. To catch the mosquitoes, they hired local boys and tasked them with climbing ladders to platforms in the treetops more than eighty feet above the ground. Positioned on the steel tower were the breeding containers, perfect for extending research on processes and patterns of egg deposition at various levels in and above the forest, to better understand the diffusion of yellow fever.[7] They are the predecessors of the breeding cages set up in that more recently built factory-laboratory for producing genetically modified mosquitoes near São Paulo.

Other experiments at the research center involved captive monkeys and mice. Dick, Haddow, and Kitchen installed six cages of rhesus macaques on wooden platforms in the canopy of mango and jackfruit trees, where various species of mosquitoes would breed. The idea was that the monkeys would be used as a kind of "sentinel species" (and they called the platforms "sentinel platforms"): Bitten by all kinds of mosquitoes while captive and suspended in the Zika forest, their blood was regularly tested for yellow fever. Key to the study design and location was that local monkeys had a relatively high incidence of immunity. In April 1947, the monkey named Rhesus 766 came down with a fever and was promptly dispatched to a nearby lab, where its blood was taken and subsequently injected into some Swiss albino mice as well as into another monkey called Rhesus 771. Most of the mice failed to develop any notable symptoms. However, the mice that had been injected intracerebrally—that is, via the brain—became ill a week and a half later, and from their brain tissue, a "filterable agent" was recovered. The same "agent" was found in Rhesus 771's blood. Several months later, the Rockefeller team

ground up the bodies of eighty-six *Aedes africanus* mosquitoes that had been captured in the containers with a solution of blood and saline, then injected the mixture into another monkey, Rhesus 758, and into the brains of six mice. Yet again, the "agent" was recovered. Haddow gave it the name of the forest in his records. The trio announced the Zika virus, "believed to be hitherto unrecorded," in a 1952 paper in the journal *Transactions of the Royal Society of Tropical Medicine and Hygiene*.[8]

Research on mosquitoes and mosquito-borne illnesses, including the recently identified Zika virus, continued on the platforms of the research center as the years passed. In 1962 and 1963, further isolations of Zika were taken from mosquitoes.[9] In 1964, D. I. H. Simpson, also based at the center, described his own experience with the "agent," claiming the first instance of "Zika virus infection in man." Referring to himself in the third person as "the patient" and as "a 28-year-old European male who had been resident in Uganda for 2½ months," Simpson noted a slight headache, rash, and fever, all of which had disappeared by the fifth day. Like the earlier experiments, blood serum samples were taken and then injected into laboratory mice, a number of which died; samples taken from their brain tissue indicated a close relationship to the virus.[10]

Looking back on these early explorations of the Zika virus, only one thing hinted at what would happen a half century later: the fact that the virus did damage to the brains of the mice that were experimented on. Dick wrote that the virus was "highly neurotropic"—meaning that it heavily affected nerve tissue—and that it had never been obtained "from tissue other than the brains of infected mice."[11] The reality was that, despite this body of work, the Zika virus remained unknown to healthcare workers for a long time. Andrew Haddow (the grandson of Alexander Haddow) and colleagues argued in 2012 that it had circulated extensively throughout sub-Saharan Africa and Southeast Asia during the latter half of the twentieth century, but with a reproductive strategy that centered on monkeys and mosquitoes, in which people only served as "incidental hosts." In areas without large populations of monkeys, humans may have functioned as primary hosts for the virus, but without major symptoms or effects. As such, Zika went unremarked on across sixty-some years of "silent transmission."[12]

It was not until 2013, during an outbreak in French Polynesia, that Zika appeared to have changed. Most of the cases presented with the same symptoms Simpson described, if any at all. But after a confirmed Zika infection, one person became ill with Guillain-Barré syndrome, a severe autoimmune disease that damages the nervous system and causes paralysis. The num-

ber of Guillain-Barré cases in the region would go on to increase during the outbreak.[13]

Somehow the Zika virus made it from the Pacific Islands to northeastern Brazil, where it found a regional population of mosquitoes flourishing in a season of heavy rains. Early in 2015, doctors began to observe cases of an illness that was not unlike soft versions of dengue fever. This mild illness was often accompanied by an equally mild rash on the skin. They also took note of a burgeoning number of emergency room visits by people with a "paralyzing syndrome." These were confirmed as manifestations of the Zika virus in June, but it wasn't until September that community clinics and maternity wards across the states of Pernambuco, Bahia, and Paraiba began to report a rise in babies born with microcephaly.[14] Following the isolation of Zika from amniotic fluid, confirming that it could cross the placenta, and the analysis of blood and tissue from a deceased infant, Zika's terrifying power to mark fetal and child life became clear. An extended network of reproduction that included asexual viral replication and the iterative human-biting and egg-laying of female mosquitoes put fetuses at risk of disability and provoked governments and organizations to call for various suspensions of, and new protocols for, baby-making. With its threat of developmental delay and its beckoning of state- or self-imposed sterility, the Zika virus came to symbolize a future of uncontrolled nonhuman reproduction and the end of human children.

Images of this marking were soon put on display for audiences far from the areas of active viral transmission, commanding the bulk of global health reporting in 2016. A rich visual, scientific, and pop-scientific archive accrued, connecting public health and health economics experts with the ordinary readers and viewers of news and entertainment television. It projected the jeopardy posed by the virus and its environments, identified a type of child to be protected, and accounted for reproduction in very particular ways. How was this new and dangerous form of Zika understood and narrated to wider publics? Where was reproduction's risk or peril, and where was its salvation? These are some of the questions I take on in this chapter, and though my emphasis is on US popular and medical culture, I cast a broad historical and conceptual net. In approaching the reproduction of Zika, mosquitoes, people, images, and numbers associated with Zika, I track the emergency's dichotomization of potential or future children, in which the existence of some compromises the life chances of others. In doing so, I begin to suggest that Zika's visual and quantitative fields foreshadow eugenic climate futures in which the possible futures of fetuses are opposed to each other.

Scrambled Equations for Reproduction

In the early days of reporting on Zika, epidemiologist Beverly Paterson wrote, "Love, sex, and babies are the foundation of human existence. Without them the human race ceases to exist. Zika, a virus that few people had heard of a month ago, has suddenly disrupted this normal course of events."[15] The disruption to which Paterson referred wasn't the aches in the joints and behind the eyes, or the waves of chills then sweat washing over the small percentage of those who experienced Zika symptoms. It was that Zika could mark a growing fetus. Questions about how long Zika could linger in semen, how often Zika would move between adults having sex, and how much faith to put into the shifting terrain of scientific knowledge on Zika slid seamlessly into questions about the health of future children—and by extension, human existence.

The emergency's public culture was, from the outset, about pregnancy, birth, motherhood, and children. This distinguished it from the "pictures from Africa showing men in spacesuits carrying dead bodies" that characterized Ebola media coverage, for example.[16] Images of vulnerable babies and maternal love predominated. Close-up shots of babies and their struggling mothers dominated the visual field; infant cries and screams were the soundtrack. The making and marking of new life drew viewers and readers in, playing on both the biological vulnerability of babies to microcephaly and the biological dependence of those babies on the women who gave birth to them. Paterson's "normal course of events" positioned these as the heart of the meaning of life. But it's also worth pausing over the proceedings in the sexed body it outlined, which the new mutation of Zika called into question. In what Lynn Morgan calls the "embryological worldview," reproductive cells are joined in a process set in motion through sex.[17] These gametes, an egg and a sperm, merge into one genetically recombined zygote cell, which through cell division develops into an embryo and then into a fetus, which is housed in the uterus. After several months of gestation, a baby is born. The public health emergency scrambled this equation for human sexual reproduction by forcibly introducing nonhuman elements into it. *Gamete + gamete = child* became *gamete + gamete + mosquito + virus = child with microcephaly*. With the aerial help of the increasingly fertile mosquito, the virus threatened to interrupt the uterine biological proceedings directed toward making the fetus into a "fully human subject."[18] Nature's errant hyperfertility in the Anthropocene imperiled the human child, both as outcome of individual physiological development and as foundation of human existence.

This mood of imperilment was expressed in the reproduction of images of microcephaly for viewers far and wide. To present the arrested development of the cranium, medical and public health diagrams in news reports counterposed babies with microcephaly to those with typical head size. The CDC's main diagram, for example, included a dotted curve arcing out from the figures with microcephaly that aimed to show what a head should look like under a healthy trajectory of child development. The diagram set out the Zika baby as an extraordinary body, which Rosemarie Garland-Thompson argues to be a central element in the narratives through which we make sense of ourselves and our place in the world.[19] Think back to the place of the child in the modern reproductive imagination: Since the nineteenth century, its development in both mind and body has been hitched to the development of human life across time, serving as a receptacle of all kinds of inheritance that could mold the future. Deviations from that path to the future, in the form of interruptions to development, have accordingly been considered tragic. For example, stories of the rubella outbreak in the mid-twentieth century focused on the loss of the child's expected adult flourishing.[20] By the twenty-first century, the sorrowful narrative gathered around interrupted child development had become a fundamental strategy for retaining abortion rights: "Messaging and storytelling that relied on prenatal disability diagnosis as a justification for access to late abortion" multiplied, casting "any potential disability as a 'painful tragedy' to be avoided at all costs."[21] This narrative echoed across the Zika public health emergency: Feminist theorist Claudia Rivera-Amarillo argues it was structured around the idea of the perfect unborn child, with the image of microcephaly "evok[ing] fear of degeneration and the need of protection."[22]

Concretely, though, the majority of images in the news were of living babies with microcephaly, which tended to depict them crying or apparently in agony. And in contrast to the CDC's abstract medical diagram, almost all the babies featured had black or brown skin. So, while Zika was narrated as an emergency that could interrupt the development of any and all future children, the condition of microcephaly was visually reproduced as a problem attached to Black and brown people.

The racialization of Zika's visual field reflects the fact that the virus principally affected poor people in Latin American countries. The city of Recife in northeastern Brazil was the site of the original microcephaly cluster, with the virus making its way to Ecuador and Colombia, and then on to the Caribbean, Central America, and Mexico by the end of 2015. However, the racialization cannot be reduced entirely to demography or geography; we must also con-

sider the long history of European and Euro-American fascination with the bodily difference of people of color. In the nineteenth century, for example, Sara Baartman, a South African Khoikhoi woman, was cruelly "exhibited as a 'freak' in London and Paris on account of the presumed particularities of her body."[23] Medical photographs of the disabled and dark-skinned "leper" circulated widely in the United States around the turn of the twentieth century, bridging fears of disease and fears of race.[24] The extraordinary body of the Zika baby, with its demonstration of the plasticity of human musculoskeletal and neurological systems to extra-human forces, bore the marks of these ligatures between abnormality, race, and dehumanization. Consider an image at the center of an anecdote nurse Julia Pineda in rural El Salvador shared with *National Geographic* during the emergency. Ten weeks pregnant, Pineda came down with a fever, her eyes grew red with irritation, and a rash blossomed on her skin, leading another nurse to unofficially diagnose her with Zika. One day, her disconsolate nine-year-old son brought a Zika information brochure home from school: It featured a drawing of a two-headed fetus enveloped by a pregnant belly.[25] Consider also the opening image of a *Washington Post* photo album on Zika. It displayed a brown-skinned woman walking next to a canal, which, the reader learned in the accompanying text, was an ideal site for mosquito reproduction. Cast around one of her shoulders was a fabric baby sling, and in it, she was carrying not a baby, but a small black dog.[26] Both images drew implicit connections between the Zika baby and the nonhuman animal. They visually captured the fear that the vulnerability of the child to errant, fertile nature might come full circle—able to interrupt physiological development to such a degree that the perfect unborn became something other than human.

Dehumanization extended to those who had carried such children. From the beginning, I was struck by the extent to which documentaries and nightly news specials laid the blame for developmental interruption on young mothers from urban Latin America. Women and girls with Zika babies were asked to explain themselves in the form of a confession, what Michel Foucault famously argued was "one of the West's most highly valued techniques for producing truth."[27] For example, in a short film on Zika in Recife, reporter Amos Roberts introduced the viewer to Leticia, age sixteen, by way of her reminiscing of a time before the baby in her arms had arrived: "Me and my girlfriends would go out at night. Always partying." The viewer's eyes are made to track between Leticia's despondent expression and the small head of her child Heitor, as Roberts announced, "There's no escape now. Young mothers have little time for adolescent dreams." Leticia's mother, Lourdes, joined her for an interview, dubbed over in English:

ROBERTS: Leticia, did you plan to get pregnant last year?

LETICIA: No.

ROBERTS: Was it a surprise then?

LETICIA: Yes.

LOURDES: She says it was a surprise—it was no surprise. If you have sex, you know you risk being knocked up if you don't take precautions.

LETICIA: His father is not involved at all. He doesn't care.

VOICEOVER: *Lourdes had high hopes for her daughter. They've been shattered—and she has trouble containing her disappointment.*

LOURDES: While he's tiny, she has to dedicate herself to him. I don't have the conditions to do it. If you want children, you have to raise your child. I raised mine. Now she has to raise hers.

ROBERTS: What upsets you the most?

LOURDES: Her rebellion. She used to be a rebel and go out. Now she's at home all the time. She's not going anywhere.[28]

This confession hinged on the presence of an authority figure who not only drew out said confession but also provided some sort of resolution through judgment. The most explicit interlocutors in this scene were the journalist, who led the interview, and Lourdes as maternal authority. But in this storying of Zika, in this public confession, the English-speaking viewers were also a faraway source of authority: They were invited to assess Leticia's confession and ultimately forgive her for her sins of the flesh—both of reckless sex and of living with mosquitoes—because of her love for Heitor. Maternal love may redeem and purify Leticia, but what are we to make of the recurrent positioning of the faraway viewer as the arbiter of judgment, as the authority in the confession scene?

Arriving at an answer to that question requires winding through the origin points of the emergency's danger: Zika and *Aedes*, with their respective molecular and minute modes of reproduction. For the fertility of mosquitoes, and thus their danger, was noted to be increasing under the effects of global environmental change. As for the virus, the reconfiguration of local ecologies for large-scale industrial agriculture raised the chances of new epidemics emerging as fast-reproducing viruses mutate at ever-increasing rates. As Rob and Rodrick Wallace wrote, "Ecosystems in which 'wild' viruses are controlled

by the rough-and-tumble of environmental stochasticity are being drastically streamlined by deforestation and plantation monoculture. Pathogen spillovers that once died out relatively quickly are now discovering chains of vulnerability, creating outbreaks of great extent, duration and momentum."[29]

Indeed, one thing about which environmental scientists speculated in the days of the original microcephaly cluster was whether the remaking of the countryside in the region played a role in the documented arrival of a new variant of *Aedes* to the region, which could have influenced the way the virus worked.[30] This hunch linked the growth of viral reproductive pathways to those of the mutable and resilient *Aedes* mosquito, reflecting and adding to the recent recasting of the environment as the chaotic progenitor of epidemics according to experts from national and international health organizations. Foreshadowing Zika, the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) stated in 2014 that global heating would not only speed up disease diffusion, but also complexify diffusion pathways with an expanding cast of variables.[31] In 2022, Zika appeared in the second part of the Sixth Assessment Report as an indicator for the IPCC's projected increase in both the number of *Aedes* mosquitoes and their geographic range, given that their worldwide distribution had already increased markedly over the previous thirty years and that their profusion was expected to be greater with every degree of increase in global temperature.[32]

Despite the apparent planetary scope of these shifts, concern about thickened worlds of dangerous nonhuman reproduction has been mapped onto the tropics, mirroring microcephaly's racialized visual profile. The reconfiguration of reproductive cycles of viruses and mosquitoes has led climate change scientists and public health experts to presage new viral futures being born between two imaginary lines scrawled around the Earth: the Tropic of Cancer and the Tropic of Capricorn.[33] In the vast and influential oeuvre of economist Jeffrey Sachs, for example, one finds that "tropical countries are doomed to poor agriculture and insect infestations, while temperate countries are said to benefit from good summers for growing food grains and healthily cold winters that eliminate insects bearing malaria, dengue, and yellow fever."[34] This mapping continues a long historical arc of Western hang-ups about the lush but dangerous fertility of tropical nature, redoubled with the dramatic character of contemporary ecosystem change. Tropicality, a colonial cultural formation, represented the tropics in two ways: paradisical and pestilential. In imaginatively hitching heat and humidity to intemperance and immorality, and cross-fertilizing with botanical taxonomies that highlighted the reproductive organs of plants, the first representation saw the tropics as highly

fertile. Disease prevalence was a central feature of the second: Tropical nature, with its ardent heat, its sumptuous humidity, its dense botany, and its thick buzz of ever-replicating insects, was inherently unhealthy.[35] The tropics were seen not only as the antithesis of the temperate zone (what Hegel called "the true theater of History"); if not properly brought under control, "then there was the ever-present possibility of transgression: the hideous threat that these monstrosities would break out from the 'place' that colonial discourse had assigned them."[36]

At the center of Sachs's map is the proposition of winter as "the world's most effective public health intervention," which we can also understand to be an intervention into tropical reproductive cycles.[37] Cold weather, in his approach, blunts the tropics' monstrously fertile swirl. By extension, Sachs is arguing that the tropics comprise a real or true physical geography in which Zika and kindred diseases naturally flourish. And it is important to underline that his map is not a stable one: Abetted by the rapidly heating environment, Zika vectors could overcome previously rigid geographical barriers. "Warmer temperatures are extending the range of various tropical vectors, such as those for malaria, dengue fever, and Zika virus," he wrote in a 2016 bulletin for the WHO. "As human and animal habitats change because of global warming, emerging and re-emerging diseases . . . and other zoonotic (animal diseases transmitted to humans) diseases are likely to appear."[38] The microgeographies of genetic mutation, the regional geographies of *Aedes aegypti*, and the global geography of climate change converged in the fear that the reproductive agents of tropical disease could burst beyond their designated geography and establish zones of fast reproduction and increased genetic mutation in temperate regions.

As an example, in January 2016 a group of researchers from the University of Notre Dame discovered a population of *Aedes aegypti* mosquitoes in Washington, DC, a finding which was then further reported by the WHO. Though the Zika virus was not detected in this population of *Aedes*, its presence was taken as a sign of things to come, a pool of possible vectors through which the virus could become established in the US capital. The researchers also pulled out genetic evidence that the mosquitoes had "overwintered," meaning that mosquito reproductive cycles had acclimatized enough for the species' presence to become firmly rooted in the area. This was not, in other words, a few rogue tropical mosquitoes finding their way into a cold neighborhood; it was instead the establishment of a reproducing population "well out of their normal range."[39] Similarly, WHO Director-General Margaret Chan cautioned in a statement that the El Niño weather pattern, which at the time was producing

very warm waters off the western coast of South America and was expected to result in an especially hot and rainy summer in the Northern Hemisphere, would expand mosquito populations in portions of the United States and southern Europe.[40] A consensus was coalescing: Multiplied pathways for the replication and mutation of viruses like Zika and increased life-cycle completions of their mosquito vectors would result in their "poleward shift," putting half a billion more people at risk of illness by 2050.[41] If the Anthropocene is defined in large part by the sixth great extinction, the end of reproduction for species being brought about at rates a thousand times faster than in previous epochs, complementing these extirpations is the amplified fertility of species like *Aedes*, the Zika virus, and many others—species whose greater reproduction is an outcome of modernity and doubles back to pose all sorts of threats to human life. In the cultural and medical apprehension of this hyperfertility of virus and vector in the Zika emergency, we can start to see a divided response that follows the well-trodden paths of colonial medicine in marking out Zika's reproductive danger as specifically and inherently tropical and the overdeveloped world as a zone entitled to special protection from that danger.

Another expression of the mood of environmental imperilment in the emergency concerned human reproduction in general—or, more specifically, its possible end. It is likely, as Rebekah Sheldon suggests, that the waning of certainty about human mastery over nature in the Anthropocene (which is distinct from the waning of the *desire* to master nature in modernity) has paved the way for the popularization or reworking of dystopian stories of human sterility. TV shows, movies, and books depicting immense environmental upheaval abound, in which the fertility of not-dead but not-alive viruses and their living vector species—portrayed as zombies, plagues, and other new congregations of matter—menace the future of the human species by clamping down on the capacity for sexual reproduction, eliminating children first and then the human species altogether. For example, P. D. James's novel *Children of Men* (which describes a future in which humans have "lost forever the power to reproduce") and Cormac McCarthy's novel *The Road* (which follows a father and a young son after an extinction event) were adapted for the screen in 2006 and 2009, respectively. The successful Hollywood film *Mad Max: Fury Road* (2015) is a tale of reproductive control and rebellion in a polluted and drought-stricken future, while the video game and HBO series *The Last of Us* (2022) depicts a future of rampant fungal reproduction, presenting a scenario of infection during childbirth as a possible cure. In these stories, we glimpse various cessations of human reproduction and reversions to the kinds of single-parent reproduction—that is, asexual

reproduction—that defined the first two billion years of life on our planet.[42] We also glimpse various modes of environmental redemption plotted through sexed female bodies of all ages.

It should not be surprising that Zika as popular culture intertwined with this sterility apocalypse genre during the public health emergency. Hulu's reworking of Margaret Atwood's *The Handmaid's Tale* into a television series illustrates this. Sarah Seltzer called Zika a "*Children of Men*-meets-*The Handmaid's Tale* dystopia where women, of course, have the most to lose," and TV writer Devindra Hardawar stated, "With all the worries about the Zika virus today, and what that means for the future of human reproduction, *The Handmaid's Tale* seems more fitting than ever."[43]

Fitting how? The novel, originally published in 1985, depicts the new nation-state of Gilead, where fertile women have been rounded up and installed as "handmaids" in the homes of high-ranking male members of society. Once a month, the husband, his wife, and their handmaid together perform the Ceremony: Timed with ovulation, the man rapes the handmaid as she lies between the legs of his wife. The Ceremony serves to produce new children while symbolically retaining the sanctity of the marital home and family structure. The first season of the television program reinterpreted the novel in a time near our own. Ordered in April 2016, it nods to the Zika public health emergency throughout. It is framed by a scene that calls to the diffuse questions surrounding the Zika virus's new links to microcephaly when the main character asks of a handmaid enduring labor pain, "What will she give birth to? A baby with a pinhead? Chances for a healthy birth are one in five." For Joe Wilcox, Zika embodied a "sudden believability" of the future portrayed in the series: "Much as the original dystopian drama appealed to me, I discounted as hugely unlikely the majority of women becoming infertile. That was 1985. In 2017, when contracted by pregnant women, the Zika virus typically causes birth defects. Suddenly, from Zika to something else, the idea of a pandemic making women infertile or leading to mass miscarriages isn't inconceivable. Nor is, in the aftermath, the rise of something like the Republic of Gilead that seeks to purge so-called sinful behaviors that brought God's punishment."[44]

In the second season, the dots between scrambled fetal development, human infertility, and environmental crisis were more richly connected through "Unbabies." Unbabies are the children conceived and carried to full term in Gilead but harmed by industrial chemicals, contaminated water, a new virus, or something else: The exact origin of the problem is not clear, but the causal relation between a noxious nonhuman agency and obstructed fetal development is. Reversing the probability of microcephaly resulting from Zika infec-

tion during pregnancy, the main character tells us that the likelihood of giving birth to an Unbaby is far greater than that of giving birth to a healthy child. The viewer learns that Gilead was established by force in response to a crisis of human fertility. Because the context of the creation of the handmaid's social role is that environmental factors have almost entirely obliterated human fertility, the Ceremony might be thought of as a reproductive technology for environmental crisis that aims to solidify the heteropatriarchal family as organizational unit and reinstate the child as the meaning of life. "Let the little children come to me," goes the prayer chanted in unison by handmaids and wives in season two, "for such is the kingdom of heaven." If we think of reproduction not only as human or nonhuman animal genetic transfer through sex, but also as the making of more lively or undead matter (in the form of, say, a virus), the Ceremony is a response to nonhuman hyperfertility and the human infertility it has the power to bring about.

Apocalyptic narratives notwithstanding, when the new mutation of Zika emerged with its causal relation to disability and a geographical reach that was yet unclear, it raised the real possibility of a certain kind of death: mass human nonreproduction, human sterility engendered by the multiplying reproductive agency of mosquito and virus. It is important to reiterate that many people in many places were soon urged to delay pregnancy. Salvadoran Deputy Health Minister Eduardo Espinoza suggested "to all the women of fertile age that they take steps to plan their pregnancy, and avoid getting pregnant between this year and next," while the Jamaican Ministry of Health called for a delay of up to twelve months, and Colombian Health Minister Alejandro Gaviria recommended a delay of six to eight months.[45] Other countries, such as Haiti and Honduras, issued similar guidance. These proposed national moratoria on reproduction danced to a similar tune as the WHO, which stated, "Men and women of reproductive age living in affected areas should be informed and orientated to consider delaying pregnancy," and the CDC, which issued an unprecedented travel alert for *all* US women "of childbearing age" not to set foot in a country with active Zika circulation.[46] Would the situation become so dire that people would have to stop reproducing? For how long and with what consequences? Would the virus mutate again, this time resulting in microcephaly with every gestational infection, or perhaps rendering people actually infertile?

These questions point to the tight linkage between understandings of fetal and child development and the roiling reproductivity of both virus and mosquito. Images of the extraordinary body and the chimera of human infertility made the virus a cause for concern for audiences far away from zones of

transmission by showcasing nature's jeopardization of the connective tissue between gestation, life, and the future. And across these examples in media and popular culture, we start to see the bifurcation of that future by place and race.

The Zika Baby's Costs

I have spent some time now describing the entwined spectacles of human malformation and infertility engendered by tropical nature's hyperfertility in the Zika public health emergency, suggesting that these factors called governments and NGOs to public health action and grabbed the attention of the public. However, these were not the only shape that fear over Zika took, and they were certainly not the primary one. Speculation over microcephaly's aggregate *costs*, in terms of both public and private infrastructures of care and lost productivity, became the dominant frame in US public culture. Let us now consider how microcephaly was produced as a national economic problem.

Diagnosed postnatally or in the womb, microcephaly is a simple descriptive term: It denotes a smaller-than-normal head size for age and almost always indicates problems in brain development. Prior to the Zika emergency, microcephaly affected two to twelve babies of every ten thousand born in the United States.[47] Those affected by Zika-associated microcephaly were anticipated to suffer seizures, intellectual disabilities, and hearing and vision problems as they grew. The burden of caring for them would fall on a mix of parents and extended care networks, private insurance, and state-funded healthcare. Public health reports around the world emphasized that even in the absence of a widescale Zika outbreak, the possibility of a sudden surge in congenital birth defects and other developmental problems in the population would tax healthcare systems having limited funds. In the United States, state-funded care would fall under the mandate of Early Intervention B-3, a federal health program designed to provide care to babies and children under age three with developmental delays. (Note the double function of the term *developmental* here, announcing lifelong impairments as well as a "'delay in development, a detour from the timeline of normative progress."[48]) Multidisciplinary support would be required, including regular hearing and vision screenings and preventative pediatric care. Babies would need to be measured across their first year of life; to address expected feeding problems, consultations would be required and the need for long-term nutritional therapy would have to be assessed. Neurologists would need to assess sleeping problems and general irritability.[49] This suite of professionals for measuring, monitoring, and man-

aging delays was imagined to be multiplied by the hundreds (thousands? millions?) and spread out across a lifespan.

The first to attribute monetary value to a single case of Zika-related microcephaly was CDC director Tom Frieden. At a press conference following the Zika Action Plan Summit in April 2016, which three hundred public health experts attended, he announced the figure of $10 million across a lifetime. That number was later reproduced in the *Washington Post* and *New York Times* and on National Public Radio and *NBC News*.[50] In the same month, alongside a long list of other organizations, the American Medical Association, the American Congress of Obstetricians and Gynecologists, the American Nurses Association, and the American Pediatric Association signed an open letter to Congress urging the allocation of additional funding for Zika management. "In addition to the human toll on children and families," the letter stated, "the CDC estimates that the average lifetime cost of caring for each child born with microcephaly will likely be millions of dollars *per child*."[51]

A key feature of this brand of national Zika accountancy was the uncharted effects that Zika during pregnancy could carry for children who would eventually become adults. A distinction was marked between microcephaly as an immediately and durably visible disability and congenital Zika syndrome (CZS), a wider collection of issues and abnormalities associated with Zika whose lifelong manifestations were unknown. This meant that so too were its costs. A report from personal finance website CBS MoneyWatch used the language of the insurance firm to explain this dilemma: "Children born with microcephaly, which has no cure, will require long-term care if they survive. Some microcephalics can live normal lives, but most suffer from severe disabilities. And while some could die early on from complications, a vast majority will need care throughout their lives. In insurance lingo this is referred to as a "long-tail" loss because the extent of the damage isn't known and is paid out over many years."[52]

Indeed, questions abounded: Would CZS shorten lives? Would children who experienced seizures continue to do so throughout their lifetime, or might they grow out of them? Would medication allay seizures, and if so, how much would it cost? What kind of learning or physical disabilities would CZS produce, and what would be required for care? Would speech, physical, and occupational therapy help? How often would children need physical exams? Would CT scans be required, and if so, at what intervals? Would vision and hearing problems associated with CZS diminish or grow over time, and what kind of support would be needed?[53] In the medical webinars on Zika I joined during this time, the image of an iceberg was often used to capture the

relationship between microcephaly and CZS, indicating the size of the known relative to the unknown. This imagery appeared in the scientific literature too. A paper by Adriana Suely de Oliveira Melo and colleagues published in *Ultrasound in Obstetrics & Gynecology* in January 2016 titled "Zika Virus Intrauterine Infection Causes Fetal Brain Damage: Tip of the Iceberg?" has been cited more than one thousand times, leading other scientists to pose the question, "How large is the Zika virus 'iceberg'?"[54] The tip was visible microcephaly, the stark and obvious, while CZS was the submerged base, its long-term effects and their costs both unknown. A consensus among public health experts congealed around the indeterminacy of CZS, tied to the sizable dent it would make in public healthcare coffers.

Later there were attempts to price microcephaly more rigorously than Frieden had done. Researchers at the CDC's Division of Reproductive Health would arrive at a more precise estimation with the help of Truven Health Analytics' MarketScan Commercial Database, a database of "real-world treatment patterns and costs" utilized by both public health researchers and businesses to assess financial and clinical performance together. Using the average costs of caring for a child with symptomatic congenital cytomegalovirus as well as the paid and unpaid costs of caring for a child with severe congenital brain injury as two stand-ins for Zika-associated microcephaly, a team led by Rui Li proposed a lifetime cost of $3.8 million.[55] Likewise, a team of epidemiologists and systems scientists modeled the potential "economic burden" of microcephaly based on different viral "attack rates" in six states in the US South. Cost estimates included direct medical costs, including to the Medicaid program, and the societal "productivity losses" incurred from screening for the virus, monitoring the infected fetus, delivering medical care to babies with microcephaly, and providing long-term care.[56] The costs of microcephaly included the anticipated lifelong medical care required for people unlikely to be able to join the labor force, as well as the partial or full removal of their primary caretakers from the labor force.

Implicit in all of this is what Robert McRuer calls "compulsory able-bodiedness," a disciplining culture with roots in nineteenth-century industrialism in which "being able-bodied means being capable of the normal physical exertions required in a particular system of labor."[57] More recent roots can be found in the technical health metrics that have become central to the work of institutions like the World Bank in attempting to quantify the "global burden of disease," as in, for example, the influential 1993 report subtitled *Investing in Health*.[58] Katherine Kenny argues that the conceptualization of health on which these metrics are based is Gary Becker's human capital theory. Becker's

student Michael Grossman further developed this theory by framing health as a central determinant of the amount of time an individual may spend on market and nonmarket activities, and driving his formulation was the idea that improving health could make more labor available to the market. In this light, lost productive time can be assigned financial value. As Kenny puts it,

> Health as a site of investment yields life, here configured as a form of time. The return on investment in health as human capital is an increased dividend of time.... Investing in one's health extends the *duration* of possible participation in market and nonmarket activity, and maximizes the term over which investment in one's health capital can be realized. Premature death represents the foreshortening of the term of investment. Health, on the other hand, extends life. But figuring health as a form of human capital results in the reconceptualization of life as a *revenue stream*.[59]

Becker, I should note, was also profoundly influential in the field of demography: His second most-cited work, *A Treatise on the Family* (1981), connected individual reproductive decision-making, microeconomics, and population governance. Jemima Repo argues that "as a harbinger of our twenty-first century ontology of reproduction, Becker introduced the idea of reproduction as a matter of utility maximization."[60] Thus, in the context of the "epistemological primacy" of cost relations and "widespread panic about the overtaxed U.S. health care system," microcephaly was constructed as a national reproductive problem in terms of demography, cost of care, and lost productive time.[61] The comfort of the futures of some people hinged on the kinds and qualities of births of others. Under the banner of ostensibly utopian economic futures, reproductive bodies had to be governed.

This particular economization of life points to another way women, fetuses, and children were racialized in the Zika public health emergency: through the explicit grammar of cost to the economy. Reproductive accounting for Zika, for example, dovetailed with immigration politics in June 2016 reports of a Honduran woman who flew to the United States and gave birth to a daughter with Zika-associated microcephaly. This brought conservative pundit Ann Coulter to draw on the economizations made by public health experts in a tweet, "Honduran woman flies to New Jersey to give birth to Zika baby. Her anchor baby will cost AT LEAST $1 million to treat." News of the birth made its way through mainstream news conglomerates in the United States, Canada, and the United Kingdom, as well as to far-right platforms like Breitbart and smaller sites and blogs aplenty. Likewise, the MoneyWatch re-

port channeled Frieden's pricing of microcephaly (now expanded into a range of $1–10 million per case) through a series of demographic, epidemiological, and gestational probabilities: the number of women in the United States who were likely to get pregnant in the summer and fall of 2016, the percentage of those women who lived in places that could be at risk of Zika, and the percentage of children born to women who had contracted Zika who would develop microcephaly:

> So here's the speculative—and very speculative at that—math. The Center for American Progress estimates that 2 million women in the U.S. will get pregnant this summer and fall, with nearly half of them living in areas potentially at risk of Zika. It's important to note that the public policy group's analysis isn't based on the actual prevalence of Zika around the country, while even if the virus spreads only a fraction of women are likely to be infected. Still, if even just one in 10 gets Zika, the CDC estimates that up to 13 percent of their unborn offspring could develop microcephaly. If just 13,000 babies are born in the U.S. with this disability or to women who migrated here for better medical treatment, the cost of keeping them alive and providing for their lifetime care could range from $13 billion to as much as $130 billion.[62]

All of the preceding scenarios demonstrate the transformation of microcephaly from a clinical term to a site of aggregate economic speculation with latent racial anxiety, in which costs were imagined to spread horizontally across the population through medical care and lost productivity and to reach temporally into the future.

The racialization of microcephaly's costs drew on the cultural association in US politics between infectious disease, prospective or already-landed immigrant populations, and the depletion of the US healthcare system. Think of the US government's categorical ban on HIV-positive immigrants a few decades prior, which included the quarantining of HIV-positive Haitian immigrants at Guantánamo Bay years after scientific communities had come to a consensus that HIV could not be transmitted through breath, touch, or any kind of day-to-day human contact. Architects of the ban employed cost-based arguments, contending that immigrants would tax the healthcare system to a degree that would compromise citizens.[63] It also tapped into the persistent painting of Medicaid—the closest approximation in the United States to public healthcare, funding medical and other health services for 75 million low-income people and people with disabilities—as a program that unfairly benefited people of color and rewarded unrestrained fertility. Because

Medicaid would have to bear the brunt of many of Zika's future costs, the emergency raised familiar questions about whose reproduction was worthy of public investment and whose was a drain on public resources.[64]

The term *anchor baby* tweeted by Coulter in reference to Zika babies denotes children born to undocumented mothers who are seen to have deliberately given birth in the United States to secure citizenship for their children. The slur's frequent circulation of late and the ongoing movement to remove birthright citizenship are indicative of post–9/11 ramping up of anti-immigration sentiment combined with the increased centrality of the fetus in US political culture and the manufactured scarcity of public funds for health. For example, when asking questions about a state-funded child healthcare program called CoverKids in 2010, Tennessee lawmaker Curry Todd publicly declared pregnant undocumented women "rats" that "multiply."[65] Mirroring the epidemiological concept of reproduction rate, the image of the proliferating rodent has long been associated with the reproduction of diseases of the poor, especially poor migrants, and as we have already had occasion to observe, it is taking on new significance as one of many expanding forms of undesirable nonhuman reproduction that threaten prized forms of human reproduction. More tangibly, though, Curry's statements turned on the simple possibility of undocumented people accessing services. Program directors stated CoverKids would not provide pregnant women with coverage but would offer "unborn" coverage because, once that child was born, it would be a US citizen. To this Todd responded, "Well they can just go out there like rats and multiply then, I guess."[66]

In his dehumanizing/animalizing formulation, was it the pregnant women who were the rats, or was it their proto-citizen children? This slippage—in which both mothers and children become one *costly procreative mass*—was a central feature of reproductive accounting in the context of Zika. One comment on a Fox News article in 2016, for example, read: "As if we didn't already have enough pregnant women sneaking over our southern border just in time to deposit their offspring here. Now we'll get all the Zika babies, who are, by our very flawed birthright citizenship law, American citizens. These babies will cost the American taxpayers a fortune in life-long care for them, and their parents, who will always be 'caregivers' and also qualify for 'benefits.'"[67] In similar form, Breitbart mapped a costly future onto a child born with microcephaly in Texas, whose mother was from Colombia: "If just 100 of these babies are born in the state, it would cost taxpayers over a billion dollars during the lifetimes of the children. The cost for the 400 pregnant women who have tested positive for Zika in the U.S. to date would total almost $4 billion."[68]

These figures—the undocumented pregnant woman, the anchor baby with microcephaly, and the numbers themselves—exemplify a field organized around debits to the US economy, with the pregnant woman spatialized as the central site of national economic contemplation. And despite the incessant march of disembodied dollar values, the national futures conceived through the figure of the Zika baby were conceived through racism and citizenship.

The Deserving and the Undeserving

In the future, perhaps the Zika public health emergency will be historicized as the public clinging to child development as a rejoinder to a particular kind of surging hyperfertility in the Anthropocene; in other words, as an attempt to reinscribe life, agency, and primacy into human genealogy at the moment when viral and entomological, as well as chemical, meteorological, and atmospheric, forces are rendering the modern fantasies of human independence from the planet and total bodily sovereignty ever more difficult to uphold. Come what may, the main form this clinging took in the culture and science of Zika in its portrayal as a global emergency was through a splitting of potential future children into the deserving and undeserving. One was actually impacted by the new strain of the virus; the other was the phantasmic realization of the perfect unborn at the center of knowledge around child development and human evolution. One embodied the abject openness of the human to nature's excess, to chaotic nonhuman reproduction; the other was synonymous with human futurity amid environmental change that impugns a once-assured future. One was a figure of fear to whom racialized healthcare system price tags were affixed; the other was to be protected.

In this chapter I have looked at some of the ways in which the public health emergency linked the wider circulation of the virus (via its hijacking of larger bodies, including mosquitoes, toward its own reproductive ends) to these two speculative children with competing futures. This culture of cost projections is, of course, made all the more complicated by the fact that the legal mandate of providing children's and disability services in the US is different from actually funding the necessary institutions and care workers well enough to ensure good care. In practice, care labor is increasingly underpaid or unpaid, and fiscally starving public services renders disability and ill health even cheaper. Nevertheless, can you see the relationship between these children? In Zika's visual and quantitative fields, the former was produced as *compromising the future of the latter*. Costs that would accrue to one would undermine the life chances of the other. Commitment to one hinged on the refusal of refuge and

care to the other. This suggests a strong link between environmental uncertainty and the financialization of future life, which tracks along modernity's racial constitution but changes it along the way.

I will say more about this as we go on. For now I want to turn explicitly to the living people who were, depending on their social and geographical location, collapsed into the medical, cultural, and juridical figurations of these two children. The positioning of the sexed female body in areas of active transmission as the singular pivot between Zika and microcephaly, between the emergency's vast nonhuman reproductive network and the economic dystopias microcephaly had the power to engender, is what set the stage for a series of on-the-ground public and reproductive health interventions. The next three chapters explore chemical vector control, contraceptive device insertion, and genetic engineering in turn.

2

BREEDING GROUND
Intervention I, Chemical Vector Control in Puerto Rico

Across the latter half of 2015 and the early months of 2016, laboratory and field scientists across the globe were busy deciphering the relationship between Zika and microcephaly. Lab tests on the virus using animal test subjects, case studies of pregnant women who had had contact with the virus at different gestational stages, and studies of larger groups of pregnant women and babies increasingly linked contact with the Zika virus during pregnancy to the birth of infants with microcephaly. It was detected in amniotic fluid, fetal tissue, the placenta, and the cerebral fluid of newborns. It was shown to restrict intrauterine growth and calcify fetal brains. It was revealed to persist in pregnant human bodies for longer than in nonpregnant human bodies (perhaps because pregnancy blunts the capacities of the immune system in order to avoid immune rejection of the growing fetus). And it was posited that Zika's potential to do damage to fetal brains and nervous systems was most potent in the first trimester, that gestational phase where the boundaries between gestating body and fetus are heavily blurred and where pregnancy, though acutely felt, is imperceptible to others. Other questions remained: How often was Zika transmitted to the fetus? How often did Zika impact the fetal

central nervous system, and how long would it take after exposure to the virus for developmental problems to manifest? Though these questions would remain unanswered for some time, a careful consensus emerged which delimited the first trimester as a time-space of human vulnerability to the wayward agency of twenty-first-century nature, with consequences reaching into futures yet unknown.

As this body of knowledge was being assembled, epidemiological surveillance was being carried out in Puerto Rico. Zika had arrived on the archipelago in May 2015, but it wasn't until December that the CDC reported the first case of autochthonous transmission. In early 2016, the CDC and the Puerto Rican Department of Health (PRDH) set about testing thousands of people for the virus, finding infections in seventy-seven of the island's seventy-eight municipalities and an accelerating viral reproduction rate as the months passed. PRDH officials advised pregnant women to prevent mosquito bites and nonpregnant women to forestall pregnancy in the months to come.[1] Following the confirmation of a case of Zika during pregnancy in February 2016, Governor Alejandro García Padilla declared a public health emergency; information about the possibility of sexual transmission was soon highlighted in local newspapers and condoms and mosquito repellent were placed under price controls. The Puerto Rican government also announced the forthcoming arrival of a range of different scientists from the CDC for Zika research and prevention activities. Director Tom Frieden visited the archipelago in March and predicted infection rates for the summer, a statistic which found its way onto the front pages of the archipelago's major newspaper: "700,000 Boricuas [Puerto Ricans] Will Suffer from Zika," or one in five.[2]

I arrived in August 2016, a week after the epidemic peaked in epidemiological terms and just as the CDC increased its forecast of cases in Puerto Rico to 850,000 (or one in four residents), due to the expected heat and humidity of late summer and the advent of hurricane season—all intensifying through climate change. It was impossible to move through San Juan without being confronted with Zika. An "unprecedented newspaper and billboard advertising campaign" on behalf of the CDC Foundation (CDCF) communicated the urgency of the virus; the crisis of reproduction saturated the city.[3] Signs over highways and pathways, on bridges and beaches, proclaimed things like "Let's take preventative actions and help avoid congenital deformations in our babies," linking present individual conduct to future collective health. Smaller notices soliciting participation in clinical studies peppered public spaces. Calls for employment opportunities in mosquito fumigation were rife. Insect repellent advertisements dotting grocery stores charged the sense of peril, en-

couraging people to toss a can or two of spray into their shopping carts along with the rice, milk, eggs, and bananas. Zika was something you were impelled to know simply by going about your everyday life, and a repertoire of signs and symbols inquired about reproductive habits and alluded to their potential consequences.

The omnipresence of Zika messaging in San Juan did not mean that the delimitation of a reproductive threat, or the terms of that delimitation, were accepted as truth. Chatting with cabdrivers, baristas, and people at bus stops revealed opinions that diverged starkly from the certainty and singleness of purpose of the public health warnings that covered the city. Repeatedly, I was made aware of a major conflict between archipelago and mainland perceptions of reproductive risk. Many people were confused by the magnitude of the CDC's predictions and the speed with which Zika overtook conversational and physical space in San Juan: Almost every time I asked someone who wasn't a doctor about the virus, the first response was, "I don't know anyone with Zika." Surely the disbelief had something to do with the asymptomatic nature of most adult cases of Zika. But how to count instances of the virus was, from the beginning, a major point of contention, and the CDC and the PRDH relied on divergent methods. The CDC's approach to defining the problem in Puerto Rico was intentionally broad: They included under the Zika umbrella all possible manifestations of the disease and only later would they sift out the confirmed cases from the likely and the negative cases. This was a very different approach from that of Puerto Rican government agencies, which measured the prevalence of Zika through cases confirmed by blood tests. This approach ensured both the exclusion of viruses related to Zika (like dengue and chikungunya) from the tallies, and—given the dearth of resources for blood testing—the portrayal of Zika as a much smaller problem than the CDC figures indicated. Disputes between Puerto Rican health officials and the CDC over the methodology of counting cases of both Zika and microcephaly reached an apex when, at one point, the former refused to meet with the latter. The numbers, it seemed, were recurrently questioned, suspected to be either inflated or vastly underreported. Either Zika had been made into a larger problem than it was, or it was dangerously underestimated.[4]

And I was struck by the extent to which people questioned whether the Zika virus was even real. There were charged declarations of US government experimentation and less pointed forms of speculation over deceit and concealment in US government interventions. Once, as I scrolled through Instagram before bed, a public service announcement flush with images of mosquitoes entered the frame. Based on my location in San Juan, an algorithm

rendered me a target for the message: "The fact that you don't know anyone infected with Zika doesn't mean that nobody has it. Zika is REAL. This too, we have to fight as a country. #PRagainstZika." Zika skepticism had been identified as a problem, with social media joining the newspaper and billboard campaign to convince people of the reproductive threats of a newly mutated mosquito-borne, sexually transmitted virus. One rich swirl of rumors wove Zika and histories of medical testing and coerced sterilizations into a single story of genocide effectuated by the US government. Another speculated about nefarious closed-door business deals between pesticide companies and the Puerto Rican government, overseen by the CDC. Some wondered whether Zika was a ruse fabricated by the Puerto Rican government in order to access more US federal funds. The legitimacy of the declaration of a reproductive emergency by both US and Puerto Rican government agencies was questioned at every turn. So was the very existence of the virus.

However, while skepticism was rife, it was also varied in tone, in the conspiring objects it named, and in degree of certainty. Walking along Avenida Fernández Juncos one day, I was taken aback by one of the CDC's notices calling for participation in a Zika study pasted on a wall, which I think helps illustrate this. On top of the solicitation for blood collection, someone had drawn an *Aedes aegypti* mosquito, stripes and all, and superimposed it over a crucifix. What did the amateur artist, who must had taken at least a few minutes to complete their work, intend for the crucifixion of the mosquito to mean? Was it a call for the death of Zika-bearing mosquitoes on the island? Was it a kind of prayer, enunciated in the midst of Zika's profound threat to children, families, the nation, and the human species, which was carried in the circulatory systems of mosquitoes? Or did it signal the chemical mosquito control program recently organized by the US government as a potentially deadly process for Puerto Rico? A mesh of meaning interleaved skepticism about Zika intervention with skepticism about such skepticism. In print, in conversation, and on the internet, whispers of US government experimentation were countered with worried statements that Zika was being ignored by the people who would be most affected by it. In the same breath one could critique the approaches to disease control being rolled out and note that the virus could completely rewrite sex, pregnancy, childbirth, childhood, and the human species. Intersecting with the "radical breakdown in meaning" in American political culture of 2016, but also predating and subverting it due to the deeply sedimented debris of empire, it was a constant buzz that infused everyday life just as the constant buzz of *Aedes aegypti* mosquitoes did in hurricane sea-

son, a skeptical orientation to both certainty that Zika was a real threat and certainty that it was overplayed or even fake.[5]

At the heart of this buzz, as the multiplicity of interpretations of the crucified mosquito drawn on the CDC study bulletin indicates, was mosquito control, the US government's primary approach to Zika management in Puerto Rico. Chemicalized ways of limiting mosquito reproduction and killing mosquitoes aimed to reduce Zika's reproduction rate, in the CDC's words, "particularly among pregnant women."[6] They spanned the intimate to the atmospheric, from pressing girls and women to coat their skin in DEET in order not to become host to Zika, to fumigating homes and apartment complexes, to proposing the indiscriminate spraying of the archipelago from planes overhead. The CDC and other federal agencies rationalized these injunctions and interventions as child-saving, but many Puerto Ricans saw them as potentially life-destroying. Key to this discrepancy was the fact that chemicalized mosquito control was neither immaterial nor disembodied: However small their granules and however low their concentrations, pesticides and other synthetic chemicals applied on the skin or dispersed from the sky can reach deep into sea, soil, and cell. Against the image of microcephaly, chemical vector control could reshape worlds.

How chemical vector control worked in Puerto Rico is the subject of this chapter. My ambition here is not to dispute its scientific rationale but to sit inside its ambiguities, and in doing so, to approach reproduction as a bundle of contested claims about the relationship between the human reproductive body, the world that is both globe and planet, planetary and particular, and the operation of imperial and patriarchal power. Who was named the beneficiary of chemical intervention? What were the coordinates of the reproductive field it invoked? And why was it so contentious? Addressing these questions requires, at the outset, explaining the "protracted liminality" of the archipelago[7]—which made for its highly charged position in the US biosecurity imaginary and also for the unease with which Puerto Ricans viewed the intervention program that imaginary licensed.

The US Biosecurity Imaginary and Contestations Thereof

The projected reproduction of Zika within the bodies of one-fifth to one-fourth of Puerto Ricans brought the archipelago to the forefront of US politics in 2016. When *New York Times* global health reporter Donald McNeil Jr. heard of the first case of Zika in Puerto Rico, he ominously penned, "So

now the disease was officially spreading on American soil."[8] The *Washington Post* announced the arrival of Zika in terms much like McNeil's: "Zika has landed forcefully in America, in one of its poorest and most vulnerable corners . . . lacking a functioning health-care system, window screens and even a spray that works against mosquitoes spreading the virus in homes, workplaces, schools, and parks." Later, the Associated Press would report "the first microcephaly case acquired on U.S. soil" in Puerto Rico.[9] The repeated invocation of the ground captures the archipelago's unique position in the geography of the virus: not merely "America's backyard," as Latin America has so often been deemed in US political discourse, it was *inside* the United States. Alongside the nascent pricing of the lifetime care for a Zika baby at $10 million, reports of Puerto Rico's position "at the U.S.'s doorstep" and on the "front lines of the battle" proliferated.[10]

The political geography of Puerto Rico explains this militarized mapping of the virus. Sovereignty over the archipelago was transferred from Spain to the United States following the Spanish-American War, and Puerto Ricans have been US citizens since 1917. Puerto Rico's status as "foreign in a domestic sense" to the United States and as a "free associated state" means that it is inside US borders, so Puerto Ricans may move between the archipelago and the mainland without restriction. There is a long history of migration to and from the mainland, with abundant flights between San Juan and mainland cities, and Puerto Rico does indeed have, as foregrounded in a plea to Congress for Zika funding, "a unique tropical climate that is an outlier compared with that of much of the continental United States."[11] Informed by the intractable interiority of the tropical archipelago to the United States in light of its heat and rains and mosquitoes, US political and medical discourse plotted the active transmission of the virus in terms of the biological and financial risks it might pose to the US demos and bios.

To begin, we can observe depictions of the circulation of people between archipelago and mainland as constitutive of Zika risk. In February 2016 the *Washington Post* produced a photo album entitled "Puerto Rico Becoming a Breeding Ground for the Zika Virus in U.S.," with statements such as "Cases of Zika are expected to rise in Puerto Rico in the coming months. And that raises the likelihood of transfer to the mainland" framing photographs of San Juan.[12] In the same vein, a study by the US health consulting firm Public Consulting Group pointed to "inadequate attention to Zika risks arising from predictable family travel between the mainland United States and its territories." It continued, "The CDC continues to issue stern travel warnings and information about Zika is more widely available at ports of departure (including airports),

however, it is likely that families will continue traveling to visit their families in U.S. territories. Given the dramatic increase in reported Zika cases in the U.S. territories, including Puerto Rico, the number of individuals returning to mainland U.S. as carriers of the Zika virus may be much higher than we are now predicting."[13] Having inverted the script of the physical geography of islands as naturally amenable to quarantine in times of infectious disease panics, this imaginary framed family and diasporic circulation as reproductive risk for the United States.

Reports also centered on people comingling with Zika-carrying mosquitoes, especially in the home. With windows on most Puerto Rican households screenless, domestic space was open to the flight paths of mosquitoes, which could seek out and bite unsuspecting people as they went about their daily activities. The writing of science reporter Helen Branswell captures the centrality of windows screens here: "On this lush Caribbean island where window screens are scarce and mosquitoes rule, public health officials are preparing for a major battle against the Zika virus."[14] Window screens promised to carve out a refuge from hungry mosquitoes, but *Aedes* are resilient organisms that actively seek out human dwellings, drawn by human scent, heat, and moisture. "Insects enter every passable space on the planet," write Andrew Dickerson, Alexander Olvera, and Yva Luc, and "physical barriers are rarely perfect."[15] Even though they are effective in reducing the number of mosquitoes indoors, window screens are not guaranteed to eliminate them entirely, and as much as serving as a physical impediment to mosquito entry, screens symbolized a separation between home and world. So, too, did air-conditioning, uncommon in working-class households in Puerto Rico but recommended by the CDC for both tourists and local pregnant women. Air-conditioning is a process of removing both heat and moisture from an interior space that depends on firmly closed windows. Having made "permanently sealing off the inside from the outside" possible for the first time in history, air-conditioning is a technology bound up in a vision of human independence from nature, performing a similar symbolic function as window screens.[16] An open, unscreened window during the time of Zika signified, in Branswell's take, "complacency" among Puerto Ricans—a major "foe" alongside the virus on which public health officials must "wage war," a rejection of proper boundary maintenance. According to Bert Putterman of the chemical pesticide corporation Rentokil, the attitude concerning mosquitoes among the Puerto Rican public was "laissez faire."[17]

The US imagination of reproductive risk in Puerto Rico was therefore organized around fear of porosity at multiple scales: the porosity of the human

body (open to mosquitoes), the porosity of domestic space (also open to mosquitoes), the porosity of the imagined distinction between mainland (temperate) and archipelago (tropical) worlds, and the porosity of the US border (open to that which is technically inside it). It was under this rubric that the reproduction rate of the virus on the archipelago would remain a prominent fixture in US news media as the months passed and would translate into a program of careful chemicalized management of mosquitoes that involved an array of US government agencies: most prominently the CDC, but also the Environmental Protection Agency (EPA), the federal agency tasked with protecting human health and the environment through regulatory mechanisms, and the federal women's assistance program Women, Infants, and Children (WIC), which established a temporary Zika information clinic in San Juan's largest shopping center.

In foregrounding the jostle of mosquitoes and human bodies as dangerously inside the United States, mainland biosecurity calculations banished the perspectives of those living in the "unincorporated territory" from the frame of reproductive risk. This exclusion has a long history. The question of "what Puerto Rico is and who Puerto Ricans are" was broached time and again in US law across the twentieth century,[18] producing constructions of sovereignty and personhood that created the conditions of possibility for Zika chemical vector control. Tasked with defining Puerto Ricans in 1901, the US Supreme Court ruled in *Downes v. Bidwell* that "natives" there were of lesser biological stock, cementing in law an interpretation of Puerto Ricans as "genetically and/or culturally inferior natives of mixed African, indigenous, and 'degenerate' Latin descent" in contradistinction to a "White race."[19] After Congress deemed Puerto Ricans US citizens in 1917, *Balzac v. People of Porto Rico* (1922) shifted the emphasis in Puerto Rican inferiority from racial to territorial, and crucially determined that the citizenship rights extended to Puerto Ricans were distinct from—that is, *not*—US constitutional rights.[20] In 1952 the US Congress established the Commonwealth of Puerto Rico, which reconfigured local governance while leaving the geo-graphing of the archipelago as a colony under the dominion of the United States intact. In the words of Melody Fonseca, "The U.S. Constitution does not apply *ex proprio vigore* to Puerto Rico, and its residents—although U.S. citizens with the possibility of legally emigrating to the United States—are still colonial citizens who cannot vote in presidential elections or have an elected representative in Congress."[21] Built into the legal architecture of the commonwealth designation is the impossibility of lawful political opposition, which is what Fonseca calls "colonial entrapment." Furthermore, residents on the archipelago receive significantly

less healthcare support, have limited access to food stamps, and—this is important for Zika—are excluded from disability benefits. Benavides puts it bluntly: "Federal statutes explicitly exclude Puerto Ricans from receiving the same federal benefits given to fellow U.S. citizens of equal or lesser need who live in any of the fifty states."[22] The formal US citizenship status of Puerto Ricans is therefore ambiguous, both haunted by scientific racism and divested of concrete political rights and access to social support.

One of the upshots of this inside-outside positioning of the archipelago has been the prioritization of mainland economic and political interests over well-being in Puerto Rico. With access to four strategic maritime routes in the Caribbean, Puerto Rico occupied a privileged position on the US military map and was considered to be a military laboratory for much of the twentieth century. While US military zones elsewhere in the region (such as Guantánamo Bay and the Panama Canal) have an enclave character, installations in Puerto Rico are ever-present, ubiquitous.[23] In the mid-twentieth century, military exercises involving more than fifty thousand US troops were conducted on Vieques, one of Puerto Rico's smaller islands; even though fishers argued early on that they were experiencing health problems related to the large-scale war games, they continued for decades.[24] Between 1983 and 1998 the US Navy dropped more than seventeen thousand tons of bombs on Vieques, as well as testing Agent Orange, napalm, and depleted uranium there—all materials that have been recently reframed as signals of the Anthropocene.[25] They linger on as toxins sedimented in soil and the fatty tissues of humans and animals: Dangerous amounts of arsenic, copper, cyanide, and lead have been detected in and around the bombing zone; flowing on easterly trade winds, they seep into the water supply, producing high rates of cancer and reproductive, respiratory, and skin ailments.[26] The dense presence of pharmaceutical firms like Pfizer, Merck, and Bayer on the archipelago joins this genealogy of instrumentalization. Pharmaceutical multinationals have been a fixture since the 1970s, when US tax law exempted profits accrued there from federal and local taxes. In their promise to deliver life-saving cures to people around the world, these firms produce a range of ill health consequences for people who live near their plants.[27] The bodies of Puerto Rican people have been made to absorb the externalities of both military experimentation and pharmaceutical production, acting as a kind of spatial fix for toxicity that has come to define our age of environmental devastation.[28]

A more recent instance of the territorial ambiguity of the archipelago and the quasi-belonging of its people to the United States is the commonwealth's $72 billion "debt crisis," the genesis of which can be found in the same law that

deemed Puerto Ricans US citizens. The 1917 Jones Act enabled Puerto Rican governments to fund local infrastructures and service provision through the issuance of bonds that are exempt from US taxes.[29] These bonds, as Marisol LeBrón argues, were junk rated, at once cheap and high-risk in addition to being tax-sheltered.[30] Investors (referred to as "vultures" [*buitres*] on the archipelago) bought them up, linked them to the pensions of ordinary people in the United States, then charged extremely high interest rates to Puerto Rican municipalities in return.[31] While "mom-and-pop mutual funds" count themselves among investors in Puerto Rican public debt, it was hedge funds that possessed the majority.[32] In April 2016, as Zika cases were rising and the summer fast approaching, Puerto Rico's Governor Alejandro García Padilla signed into law an emergency bill that enabled municipalities to cease payments on the debt in order to continue basic local service provision. This move was prompted by the circulation of a draft of how the US Congress would address the recurrent defaulting on payments, which suggested that a financial control board would be established to "oversee" the archipelago's internal financial decision-making to ensure payments to hedge funds. It drew on the prevalent "doctrine of nonviability," the idea that the forms of self-governance that the archipelago had been granted by Congress in 1952 just did not work.[33]

It is easy to see why César Ayala and Rafael Bernabe designate Puerto Rico a "possession of but not part of the United States."[34] Its suffusion with military and pharmaceutical interests and the intimation of a return to more direct forms of colonial rule demonstrate a precedent of mapping the archipelago as outside the United States in an ethical sense, in which political rights, already tempered by notions of racial and territorial inferiority, may be selectively suspended. Lauren Derby argues that these territorializations have "created a robust rumor culture about what goes on behind closed doors," the "reigning presumption [of which] is that the U.S. government is always doing far more than it will own up to."[35] This explains why the US government's designation of Puerto Rico as the problem, a "breeding ground" for Zika in which mosquitoes freely feasted on pregnant women, against the backdrop of the postulation of the nameless and placeless child as the victim, was imbued with a hearty ethos of distrust from the start. But how did the US government's solution to address the reproductive nexus of Zika, mosquitoes, and women on the archipelago—chemical vector control—actually work?

Like Perfume

Building on a long tradition in modern public health, mosquito control was the dominant approach to limiting the reproduction rate of Zika in Puerto Rico.[36] This strategy stemmed from the fact that mosquito bites were the most common form of viral transmission, which meant that effective chemical vector control could eliminate the need to prevent pregnancies. This was important, given the archbishop of San Juan's denunciation of the CDC's and local government agencies' call for the use of birth control, including condoms, to prevent microcephaly.[37] Through cleaving off mosquito transmission from sexual transmission, and also from the politics of pregnancy prevention or termination, a fragile alliance was born between the CDC and other federal agencies, the PRDH, pest control firms Rentokil and Oliver Exterminating Corporation, multinational corporations such as SC Johnson and Spectrum Brands that manufactured personal insect repellent, municipal governments, and local community groups. It sought to chemically barricade off girls and women from the mosquitoes that served as host organisms for Zika's reproductive ends, and to obliterate sites and opportunities for mosquito reproduction.

The program comprised many tasks in its early months. Millions of discarded tires were removed from neighborhoods and ditches, as *Aedes* have a special affinity for those that have collected rainwater as a place to deposit eggs. Screens were installed on the doors and windows of some apartments; orientations on mosquito control were conducted for the boards of the public housing projects that dot the archipelago. Fumigation brigades were formed through Zika job recruitment fairs that drew thousands of would-be workers. Public health goodie bags containing bed nets, standing-water treatment tabs, DEET-based insect repellent, and sometimes condoms were distributed. And most importantly, people were recurrently instructed to apply a coating of DEET-based insect repellent in the morning and reapply throughout the day. Mosquito regulation brought together federal, commonwealth, and municipal governments with the chemical companies seeking to monopolize an expanding repellent market around the objective of cutting off Zika's most-traveled pathways to and between human bodies.[38]

Yet this broad effort soon focused the spotlight on women and girls. As reports on the risk the archipelago posed to the mainland proliferated in the early months of 2016, so too did examinations of the sexed living-being of Puerto Ricans. Because Zika's potential to cause disability was located in the time-space of pregnancy, the body that could become pregnant was a major

area of intervention. Surveys of the island from years past were unearthed and given new meanings, and new surveying mechanisms bloomed. Bodies and behaviors were tabulated and aggregate risks assessed. The number of women and girls "of reproductive age (15–44 years)" who did not desire pregnancy but were not practicing effective contraception was counted at 138,000.[39] CDC research also centered the insect repellent practices of women who had recently given birth, which operated as a behavioral link between research on female reproductivity and research that mapped the insecticide resistance of mosquitoes on different regions of the island.[40] If, as we have already had occasion to observe, the US biosecurity imagination envisioned Zika as a diffuse reproductive danger in circulation with the reproductive cycles of tropical mosquitoes, CDC expertise focalized the sexed female body as the interface between that diffuse danger and its specific, human activation in mass microcephaly. As a suite, CDC studies framed that body as the hinge between *Aedes aegypti* and the Zika babies that were projected to cost millions of dollars.

This equation translated into assigning Puerto Rican women and girls the responsibility for mosquito regulation within the territorial borders of the United States. This happened at four sites. The body, the first site, concerns the interleaving of mosquito control with female beauty regimens. The injunction to wear insect repellent throughout the day played a sizable role in the CDCF's advertising campaign: Everyone was told, in radio public service announcements, by doctors, in the advertisements that punctuated YouTube videos, on street signs, and even on billboards over Puerto Rico Highway 2, to make a daily practice of wearing strong insect repellent, and blending the imperative into everyday landscapes of social reproduction, advertisements were rife in shops that positioned repellent next to cleaning products. But this injunction *was directed at women*: The refrain I heard repeated time and again was to "wear DEET like perfume." Stripped back, applying and reapplying repellent throughout the day is not unlike the tasks that women and girls are daily called to do in centripetal relation to their bodies, modifying on a precise timetable their face, skin, and hair with tints and fragrances and other cosmetic concoctions.[41] The exhortation to choose DEET as one's perfume was bound up in gendered bodily disciplines: DEET was never likened to cologne or aftershave.

The second site was the home. Alongside the timetable of repellent application was the requirement of clearing the domestic space of potential mosquito breeding sites, which could be done manually or chemically. Ed Cohen argues that modern approaches to health turn on the idea that bodies should be separate from other bodies and separate from their environment, and as

the concern about window screens (which mark off the home from nature) and air-conditioning (which goes even further to purify the home of nature and seal it off) attests, the unremitting matter of boundary maintenance extended to domestic space.[42] The home was a space for human reproduction, from which mosquito reproduction had to be banished.

The imperative to remove mosquitoes from the home is, of course, understandable—no one enjoys being bitten or torn from sleep by their shrill buzz—but, as Claudia Rivera-Amarillo and Alejandro Camacho have argued, one curious feature of the reproductive conduct of *Aedes aegypti* cannot be ignored: They are peridomestic organisms, meaning that they have evolved to live and breed in and around human habitations. That is their nature. Despite this, the CDC's approach to the Zika problem held that domestic space was the domain for the continuation of the human family, not for the mosquito breeding that threatened the human family. One of the paper games for children that the CDC created and distributed as part of their collection of Zika educational materials in Spanish called for a child to, with a pencil or crayon, guide a nuclear family and their pet dog through a maze by avoiding the mosquitoes positioned on different routes, in order to arrive safely home. By presenting mosquitoes as obstacles one must overcome to win the game, and making winning synonymous with home, this little game suggested that domestic space was—or at least should be—sealed off from mosquitoes. The key point here is that domestic boundary maintenance, like most cleaning and hygiene-centered labor, was treated as the task of women, who were cast, as Rivera-Amarillo and Camargo put it, "as central agents in the eradication of the virus via specific mechanisms of water and domestic space management."[43] As such, Puerto Rican women were seen as emissaries of the future biological and financial health of the United States through the reduction of their personhood not only to the reproductive potential of their bodies, but also to their domestic space via the requirements of purifying the home of the reproductive potential of *Aedes*.

The school was the third site. Akin to "Girl Effect" international development programs that render girls and their reproductivity responsible for the financial uplift of their communities, schoolchildren were called upon to conduct mosquito control.[44] This program again was simply and strikingly gendered: Public school teachers were instructed to distribute cans of repellent to *girls* in the classroom, sexualizing them as proto-pregnant subjects.[45]

And fourth, women were cast as agents of mosquito control at the government welfare office. The WIC program provides nutritional and childcare counseling and food vouchers to more than 90 percent of pregnant women

in Puerto Rico; it was utilized for Zika management in order to reach as many women as possible. (A CDC survey found that more than 60 percent of the women who were aware of the Zika virus had been informed by WIC employees, compared with 40 percent by television, 25 percent by a doctor, and less than 20 percent by Facebook and other websites, indicating relative success in this endeavor and providing a rationale for continuing to make use of the agency to access women.[46]) US government food assistance at once provided women with a monthly lifeline in the context of food insecurity and instructed them on the self-mitigation of mosquito bites. In each of these four sites, women and girls on the island were made into *subjects* of chemical vector control: Through their self-regulation, the US population could be secured against Zika's compendium of biological and financial threats.

It is crucial to note that the CDC's instructions for women in Puerto Rico to maintain a DEET skin barrier against a turbulent swirl of Anthropocene reproduction, as well as to preserve the home as distinct from that world, did not differ from instructions given to women on the mainland: Those in areas of active Zika transmission, like Florida and Texas, were urged to do exactly the same things.[47] Where women's self-regulation on the island differed was its interlinkage with coerced chemical intervention into homes. In the summer of 2016, physician Wanda Beltrán brought a case to the attention of the Puerto Rican Civil Rights Center, proclaiming that WIC beneficiaries had been coerced into signing a form that allowed government officials to freely enter their homes for fumigation.[48] Reports regarding how many women signed varied: Some said more than twenty thousand, others said closer to ten thousand. The women were not given copies of the form for their own records and were told not to discuss the matter with their doctors. WIC sent the registry of signatories to the CDC, which then coordinated the fumigation of more than two thousand homes with the chemical pesticide Deltamethrin—though the forms made no mention of what chemical might be sprayed nor of any associated health risks to humans or unborn children, while at the same time releasing the Puerto Rican and US governments from liability for any health damages related to fumigation.[49] Furthermore, public disclosure about the scientific rationale behind the fumigation of homes with Deltamethrin was limited. In the preceding months, CDC scientists had been gathering *Aedes* specimens from municipalities across the island to assess whether, and to what extent, they were resistant to the insecticide in bottle bioassay tests. Maps of chemical susceptibility released later depicted the limits of the organization's capacity to bring mosquitoes under control: Deltamethrin may have been claimed to jam mosquito nervous systems, but in fact, the bugs were re-

sistant to Deltamethrin in many areas, including the urban areas of San Juan and Ponce. Yet research about this and other insecticides on the island was not made public, nor was information about the effectiveness of insecticides in actually preventing mosquito bites.[50] Any health risks of exposure were designated acceptable.

In fact, it appears that US government agencies assumed Puerto Rican women's self-governance vis-à-vis *Aedes aegypti* to be insufficient from the beginning. As news of the WIC- and CDC-coordinated domestic fumigations began to circulate, people noted earlier rounds of unauthorized fumigation of the homes of several thousand pregnant recipients of WIC. Carried out by Oliver Exterminating Corporation, this round of fumigation happened without the mediation of a signed document and therefore without even the pretense of transparency. US government chemical intervention into domestic spaces thus did not follow the dissemination of instructions for women's self-regulation of body and home as an escalating stage in Zika management, but was carried out in secret alongside the dissemination of those instructions. Mosquito control assigned responsibility to Puerto Rican women for Zika's future in a broad US national reproductive system, and the assumption of irresponsibility would inform a more expansive and ambitious plan for the chemical reduction of Zika's reproduction rate—one that would ignite an archipelago-wide controversy.

The Naled Aerial Fumigation Plan

As the summer of 2016 deepened, rumors began circulating that the entire archipelago would be fumigated with the insecticide Naled from planes overhead. (Some of those rumors suggested that spraying already had begun.) Through official and unofficial channels, an aerial fumigation plan under the auspices of the CDC was soon confirmed, and agricultural organizations, environmental organizations, and doctors and other medical professionals set out to alert people far and wide of the possible harm that could result from blanketing Puerto Rico with the chemical. The plan scaled up the injunction for insect repellent use and the covert fumigations from the body and home to the "unincorporated territory" as a whole, seeking to rapidly reduce mosquito numbers by releasing Naled from airplanes.

Three components of the aerial fumigation plan must be highlighted: the why, the how, and the effects. As for the why, aerial fumigation was pitched as a form of anticipatory reproductive governance against an explosion in Zika's rate of reproduction among Puerto Rican pregnant women generally

and, down the line, in cases of microcephaly. "If any part of the continental US had the kind of spread of Zika that Puerto Rico has now, they would have sprayed months ago. This is more a question of neglect than anything else," stated CDC director Tom Frieden, before continuing, "If we wait until children with microcephaly are born, it will be too late"; Naled was the "island's best defense."[51] A contextless image of future children was named the beneficiary of aerial fumigation; their neglect was also a neglect of the future writ large. Crucially, this rationale was tied to instructions for insect repellent use: Puerto Rico WIC director Dana Miró stated aerial fumigation was necessary because Puerto Ricans were not following CDC guidelines for mitigating against mosquito bites.[52] In a biopolitical reverberation of the "doctrine of nonviability," the plan was posed as a corrective measure against women's and girls' failure to modulate their bodies in relation to Zika-bearing female mosquitoes and to prevent themselves from becoming host organisms for Zika replication.

In terms of how, aerial fumigation was premised on the obliteration of mosquitoes across large areas on the main island through the use of spraying technologies, which encompassed the mixing of liquids and solids in correct ratios to "bring chemicals to 'life'" and the pressurization of the reconstituted liquid into a mist that could be dispersed.[53] It is the granularity of spray technologies that enables broad coverage, especially for the "ultra-low volume" spray proposed for Zika intervention. Developed by US military entomologists in World War II, aerial chemical vector control is known as a "space spray since the goal is to drift droplets through a particular space resulting in contact with flying insects."[54] "Space spray" is celebrated for being able to access areas that are inaccessible to backpack- or truck-mounted spray units—or to kill mosquitoes that would otherwise reach the skin of sexed female bodies unadorned with repellent. In fact, the Naled plan promised an expansive geography of fumigation as redress to women's and girls' supposed lack of self-management, and this is another way chemical vector control on the mainland diverged sharply from that in Puerto Rico: The CDC's discussions of the former concerned a six-block area where active Zika transmission had been identified, while in Puerto Rico the geography of fumigation wasn't made clear to the public, though it was expected to "cover large tracts of a geographically diverse island."[55]

As for the effects, a key aspect of the aerial fumigation plan was its presumed safety. Naled is an organophosphate pesticide, one of the more than 85,000 human-created industrial chemicals.[56] When dispersed from airplanes in tiny aerosol beads, the pesticide forms a chemical suspension. Hanging in

the air, it comes into contact with mosquitoes and inhibits enzymes in their bodies that are necessary for the smooth functioning of the nervous system, resulting in the death of the mosquito. Interestingly, organophosphates like Naled were vaunted as a safe alternative to DDT following the public outcry about and ultimate ban of that pesticide sparked by Rachel Carson's *Silent Spring* (1962). Carson herself, however, was concerned about the safety of organophosphates because they work by harming nervous systems generally—not just those of the creatures targeted for obliteration.[57] (I find it instructive, too, that the spiteful takedown Monsanto published on *Silent Spring* described a world being entirely overrun by insects in the absence of pesticides, foreshadowing some of the fears about insect and rodent hyperfertility that we have been tracing.)[58]

CDC documentation cited Naled's 1959 approval by the EPA and its half century of use in mosquito control and agriculture on the mainland as evidence for its safety for use during the Zika emergency. It also argued that the small ratio of active Naled to the area of application—less than two tablespoons per acre—was below the ratio that could cause negative health impacts in the area of application.[59] (More generally, the EPA contends that Naled spray "is dilute . . . and the amount that ultimately floats to the ground is small and dissipates quickly.")[60]

Like all pesticides, Naled falls under the jurisdiction of the Federal Insecticide, Fungicide, and Rodenticide Act (1947) and the EPA's Office of Pesticides Program (OPP). The astonishing work of journalist Sharon Lerner reveals "enormous corporate influence [that] has weakened, and in some cases, shut down the meaningful regulation of pesticides in the U.S."[61] In fact, Naled was pulled from the market in the European Union in 2012 due to its "unacceptable risk" to the environment and health, as well as tests indicating it was not sufficiently effective relative to that risk.[62] In lawyer Lori Ann Burd's assessment, "As far as this office [the OPP] goes, extinction is not unreasonable, mass poisonings are not unreasonable, and pollinator population collapses are not unreasonable."[63] This institutional setting goes some way towards explaining why Naled was granted the stamp of safety despite scientific studies having raised legitimate concerns over its toxicity to humans and bees, the pressing points being that dependence on insecticides could facilitate insect resistance—that is, the natural selection for insect populations that are less affected or unaffected by the chemical—and that the EPA's approval relied on industry-sponsored studies.[64]

This approach is based on framings of chemicals as discrete and isolated units in modern toxicology, which renders chemicals visible to the human eye

by structural diagrams and names them "one by one, as isolated entities of purely technical qualities without context," obscuring compound or unforeseen reactions with other synthetic chemicals or with living matter.[65] The idea of chemical exposure itself emerged in the rough waters between industrial production and environmental regulation in the early twentieth century. The first air quality regulations sought to limit work-related diseases among factory workers: From "homeostasis," physiologist Walter Cannon's notion that bodies are inherently self-regulating, early toxicologists developed the concept of the chemical threshold, which holds that the body can handle toxins without suffering permanent damage, provided that the exposure level is low enough.[66] The result was a science of correlations between specific, quantifiable exposures in a defined worker environment and specific, quantifiable effects in the worker body. The transposition of the factory onto the wider world has had profound implications for contemporary legalities of pesticide use: Industry litigators are practiced in strategically arguing the "multiplicity of exposures, which subverts the ability to isolate the harmful effects of any specific exposures in an era where chemical exposures are only regulatable and litigable as specific entities."[67]

The aerial Naled fumigation plan brought these abstractions to bear on life in the "unincorporated territory," and the understandings of causality and essence at the heart of its claim to safety were similar in structure to those at the heart of the modern reproductive imagination. Discrete units with essences interact with other discrete units of essences to produce outcomes internally related to those essences. In the latter scene, it is two sexually mature humans that entwine through sexual recombination to "pass on" genetic nature to a child, who then has its own genetic nature. In the former scene, it is Naled that has a defined chemical nature, present at the moment of industrial production and made observable in diagrams. It was the possibility of necessary or internal relationships (as opposed to contingent relationships) between the substance's essence and human illness (also defined as discrete, essential, and verifiable) that was subjected to scrutiny—and not found. A filial theory of causality—genealogical, linear—as opposed to a conditional and historical one prevailed in calculations of potential chemical harm.

Notwithstanding the logics of chemical vector control at the sweeping scale of the archipelago, what is clear is the despotic manner in which the plan had been articulated in circles of government and the lack of transparency for those who would have to live with its effects. Following the scripting of the virus on the archipelago as an American problem and the narrowing of the public health gaze onto relationships between Puerto Rican women's

and girls' bodies and female mosquitoes, the Zika gaze widened again to the territorial in the Naled plan.

That widening coincided with a dramatic reduction in Puerto Rico's "already limited sovereignty" through three legal reconfigurations.[68] On June 9, 2016, the case *Puerto Rico v. Sanchez Valle* posed the question of "dual sovereignty doctrine," asking whether Puerto Rico was a separate sovereign like the fifty states of the United States. In ruling that an individual cannot be tried twice for the same criminal offense under the same sovereignty, the Supreme Court not only struck at the heart of the archipelago's ambiguous sovereign status but changed the very terms in which questions about that ambiguity could be posed. In jurist Juan R. Torruella's reading, the decision argued that it was not the "degree of autonomy" that mattered but "the source of Puerto Rico's power to prosecute."[69] It is worth pausing over the Court's approach here. Because all of the fifty states were sovereign entities before joining the United States, they possessed an independent source of sovereign power, a source that originated with the state and was not expunged through incorporation into the nation. By contrast, the Court ruled, Puerto Rico's power to prosecute originated in Congress; it was Congress that deemed Puerto Rico a "free associated state" in 1952, it was Congress that bestowed upon Puerto Rico the power to author its own constitution, and it was Congress that then had to approve said constitution. The *Sanchez Valle* ruling hardened the archipelago's subordinate legal territoriality while naturalizing US state power as organic, almost divinely mandated, confirming "that Puerto Rico is not 'alike in power, dignity, and authority' to any of the fifty states, but rather is in a subordinary condition under the Territorial Clause, i.e. in a colonial status."[70]

Just four days later, the Supreme Court ruled on *Puerto Rico v. Franklin California Tax-Free Trust*, the case that confronted Governor Alejandro García Padilla's recent provision for local government services to be given priority over the repayment of debts to hedge funds. Here the Court argued that standing federal bankruptcy law, which deprived Puerto Rico of the right to declare bankruptcy that municipalities in the United States have, precluded local bankruptcy law. The *ley de quiebra criolla*—literally "creole bankruptcy law," with *creole* in this formulation signifying native or autochthonous—had carved out a legal avenue through which Puerto Rican municipalities could access debt relief. *Franklin* was the hedge funds' challenge to bankruptcy protections; in the end it annulled "creole bankruptcy" and reaffirmed Congress's prerogative to restructure the archipelago's economy as it saw fit.[71] In doing so the Court established Puerto Rico as two conflicting territorialities at once: as one state in the United States, which made the archipelago subject to US

bankruptcy law, and as not of the United States, which excluded it from the relief that US bankruptcy law could provide to municipalities. What is more, the unspoken territoriality in these legal gymnastics, the territoriality lurking in the shadow of the Court's decision, was Puerto Rican sovereignty—the ability to author and realize its own bankruptcy law. Its negation was the condition of possibility for the former two mappings.

At the end of June, President Obama signed the Puerto Rico Oversight, Management, and Economic Stability Act (PROMESA) into law. Drawing explicitly on the terms set out by *Franklin*, PROMESA instantiated a financial control board that would have total authority over public spending (and whose expenses would be covered by Puerto Rican taxpayers). It became known as *la junta* on the island, suggesting parallels between the control board—which would be composed of seven presidential appointees, only one of whom would be a resident of Puerto Rico—and a military dictatorship.[72] (The act's acronym is the Spanish word for "promise," which was subverted by activists with the catchphrase *se acabaron las promesas*—"promises are over.") PROMESA drew on the idea that the degree of self-governance that the island had been granted by Congress in 1952 had been revealed to be inefficient and irresponsible: Local governments simply borrowed more than they could afford. As Alejandro Torres Rivera argued, it was much more than an economic measure; it was "a political measure directed at throwing back . . . the model of government created in the 1950s" and "accenting the colonial power of the United States over our country."[73] The "free" of the "free associated state" of Puerto Rico, as we have seen, has always been locked in and constrained by US sovereign power, but PROMESA stripped the island of even the pretense of self-governance, wearing down trust in US government agencies as well as in the ruling Popular Democratic Party, the same party that had played a part in engineering the island's political status in 1952. The *junta* would hold the sovereign power to disallow or annul any local legislation that would tend to local healthcare, education, infrastructure, or other public services over debt repayment: It prioritized, in law, mainland hedge funds.

A mere few weeks later, *Telemundo* reported that the CDC had sent a massive shipment of Naled to Puerto Rico without the knowledge of local authorities. Conflicting reports about the location of and jurisdiction over the Naled shipment emerged in the island's major news media outlets. *Metro PR* said a shipment of Naled had been registered at the Isla Grande hangar, while *El Nuevo Día* re-reported what had been broadcast on Radio Isla: A large shipment of Naled was on the island, not at Isla Grande but somewhere, and the Puerto Rican government did not know where it was. Hours

later, *El Nuevo Día* reported that the Puerto Rican government had located the Naled—25,000 pounds of it—in a large container ship off San Juan Harbor.[74] Later it came to light that, in an earlier meeting, the CDC had informed representatives of Puerto Rican municipalities and government agencies that the archipelago would be fumigated with Naled "with or without the consent and cooperation of local authorities."[75]

Biopolitics, Geopolitics, and Chemical Harm

US government institutions principally apprehended the increased reproductive rate of Zika in Puerto Rico as a hazard to public health in the mainland United States. Because of its dual position as an "unincorporated territory" and a tropical archipelago with a high viral reproductive rate, US government public health institutions mapped it as both inside and outside the United States. I mean this in both embodied and disembodied senses: Microcephaly exemplified the capacity of extra-human nature to shape and mold the human form and carried with it unknown but inevitable debits to the national economy in costs of care and lost productivity. The present conduct of Puerto Ricans was bound to the biological and financial future of the US nation. The archipelago was thus *incorporated* into the US nation through an imaginary of biological and economic risk, despite its status as "unincorporated territory." At the same time, Puerto Rico was produced as outside the United States in an ethical sense, in which various forms of chemical intervention were planned without the consent of the ordinary people whose bodies were targeted.

As we have seen in the logics of insect repellant guidelines and domestic fumigation, this tangled geo-graphing of reproductive risk specifically spatialized the sexed female body as the threshold between the Zika virus and its mosquito carriers, on the one hand, and the future, on the other. Risk, as Becky Mansfield reminds us, is very different from uncertainty: It is a mode of managing uncertainty on the behalf of specific communities and toward specific interests.[76] Risk of this new mutation of Zika was very different from uncertainty about it. That Zika can be transmitted through a chance mosquito bite, reside in humans without producing symptoms, and harm growing fetuses speaks to the uncertainties of living on a dynamic planet, of the "precarious global interdependency of human, animal, and viral ecologies."[77] By contrast, in the chemical vector program's framework of reproductive risk, the existential and planetary problem of vulnerability to a reconfigured infectious disease was reduced to the individual actions of Puerto Rican women

and the ripple effects those actions might hold for the mainland United States and the financial health of its institutions.

And to be straightforward, federal agencies recurrently stated that women had *not* properly prevented themselves from becoming hosts to Zika by reducing their comingling with mosquitoes on the surface of their bodies and in the spaces of their homes. The program's incitement to women's self-management was followed not long after by the negation of their self-management, preemptively calling their efforts a failure without leaving any space for "vernacular knowledge about how to avoid mosquito bites in the Caribbean," which may not be recognized by science or medicine.[78] They were interpreted to have flouted insect repellent guidelines, exposing themselves to the bite of *Aedes aegypti* and thereby exposing the United States to the chance of costly microcephaly. Accordingly, US paternalism held, they had to be shielded from the mosquito by other means.

The other means was the threat of spraying a chemical associated with toxicity concerns from above without consent, a move that can be read as an aggressive display of US sovereign power. The vertical structure of the aerial fumigation plan was both a callback to more overt expressions of US sovereign power (especially bomb testing) and a visual reminder of recently expanded US control over everyday governance on the archipelago. The scales of chemical intervention—body, home, and islands—were therefore connected: Covert domestic fumigation and the Naled aerial fumigation plan were deemed necessary because women and girls were perceived to fall short in self-governance relative to Zika-bearing mosquitoes. As thresholds, the liminal space of the pregnant body and the liminal space of the archipelago—both "nonviable" in terms of governance, required outside control so as to avoid pregnancies deemed "nonviable" in the terms of compulsory ablebodiedness and economized life.

It is crucial to be clear about what chemicalized sovereign power could entail, if deployed: In order for abstract people in the United States to live more prosperously in the future, the Naled plan would expose some Puerto Ricans to the chance of long-term chemical harm due to the "granularity" of chemical spray technologies. Such technologies are bound up with peril as much as promise, as Vanessa Agard-Jones argues: The expansive spatial reach of the planned aerial fumigation was also the expansive reach of its possible health and environmental effects.[79] Naled could exceed the secret spaces designated for its application, moving into and spatially across the Earth on sultry winds and rains. Its scattershot molecular relations with other entities would not necessarily abide by the filial model of causality in human legal frameworks.

It could accrete across extended temporalities that would escape immediate measurement; it could even interact with the past chemical exposures by military or pharmaceutical infrastructures. Enabled by the racialization of the island in US law on the basis of presumed biological and territorial inferiority, the Naled plan could, in effect, write racism into both body biology and ecology. Any deployment of chemicalized sovereign power would engage people's bodies and lands, stretching the partial suspension of Puerto Rican rights during the Zika public health emergency into intergenerational futures.[80]

It is also crucial to be clear about why aerial fumigation was ultimately not carried out. While the "for the children" rhetoric was wrapped up in a colonial rule both historically durable and newly tightened, it was also, as Adriana Garriga-López notes, marshaled for anticolonial aims.[81] The report of the shipment Naled on the nightly news in Puerto Rico added a jolt to already buzzing street talk about chemical fumigation. The drama over the Naled shipment's location was reported (and reinforced with a photograph of the container ship under suspicion) on Facebook by Jay Fonseca, a journalist whose page garners a following of more than one million on the archipelago and in the diaspora. In an informal interview on the page, an investigative reporter noted that inspection rules require all pesticides and accompanying devices arriving to the "unincorporated territory" to be registered with the Department of Agriculture, even those coming from the US mainland—hinting that these rules may have not been followed. In the weeks that followed, these photos and videos became a forum for people to speculate about whether aerial fumigation had already been carried out in secret. Thousands of people wrote of skin rashes, feeling unwell, and breathing problems, and submitted photographs of bee deaths. In an echo of a globally circulating conspiracy theory about a CDC cover-up of a link between the measles, mumps, and rubella vaccine and autism, and reflecting what Alexis Shotwell calls the "purity politics" of both vaccination and environmental pollutants, some people suggested that Naled could directly produce autism.[82] This conspiracy, which has the flavors of being hidden, discoverable, and mind-blowing, is much more dramatic than the real-life conspiracy of the plan's operation without consent. That it resonated with the public hints at the US government's structural withholding of the information people needed to interpret various kinds of Zika information. People were, in other words, "being conspired against."[83] Others wrote of the lack of transparency and concerns over the long-term effects of pesticides. The speculation thus spanned from environmental contamination in a broad, amorphous sense to antivax conspiracy theories emerging in online communities, which were themselves

emerging from a more general crisis in meaning, to specific distrust of the CDC's guarantee of safety.

Naled opposition bloomed in the heady days that followed through the formation of the United Front Against Aerial Fumigation with its own assemblage of experts: the *colegios* (mandatory guilds) of physicians, engineers, and chemists; the University of Puerto Rico School of Public Health; oncologists; lawyers; and ecologists from academic and community-based institutions.[84] Thousands gathered for demonstrations, including one in front of the CDC building in San Juan, as well as nighttime discussions throughout the city. People held up signs reading, "Don't fumigate us" and "I'm not your fuckin' experiment" and charged the CDC with "environmental terrorism."[85] Naled's banning in the European Union was a recurring point of reference in articulating its danger, as was its toxicity classification by the EPA as a "category 1" with respect to eye irritation and dermal irritation. People called for transparency on the quantities of Naled proposed for use and the specific areas delimited for spraying, as well as guidelines for people to minimize health risks. What united these disparate strands of opposition was concern over the unknown consequences of Naled exposure, the fact that the CDC had not only not sought the consent of the Puerto Rican authorities but had openly flouted those authorities, and the lack of transparency on the geography of planned fumigation.

There was also active legal resistance within the US court system. In the US District Court for Puerto Rico, San Juan Mayor Carmen Yulín Cruz-Soto filed suit on behalf of the municipality of San Juan. Pursuant to the Endangered Species Act (ESA) and the National Environmental Policy Act (NEPA), the suit demanded a trial by jury for a long list of defendants, including the CDC, the commonwealth government of Puerto Rico, and three corporations. The objective of the suit was to prevent the CDC from spraying until the environmental impact statement required by NEPA had been provided, in order to involve the public in decision-making related to environmental health. Of NEPA, Juanita Sundberg writes that "although there are no guarantees, [it] legitimizes the concerns of citizen-subjects about clean air and water and about culturally significant landscapes indispensable to the fabric and long-term wellbeing of multispecies communities."[86] The suit argued aerial fumigation would "pose a significant risk to the well-being of several species of fish, wildlife and plants."[87]

In addition to endangered species, the suit highlighted water systems, noting Naled's label warning that the chemical should not be used in or around bodies of water. "The quality of the multiple waterways and the San Juan

estuary systems, as well as the safety of wildlife and fish that inhabit said ecosystems and bodies of water directly affects the health, recreational, aesthetic, commercial, and environmental interests of the MSJ [municipality of San Juan]," it charged. Recall that less than a month earlier, the US Supreme Court had reaffirmed the incapacity of the Puerto Rican government to either author its own bankruptcy law or authorize municipalities like San Juan to restructure debt. The anti-Naled lawsuit's appeal to water quality came just weeks after the US Geological Survey threatened to stop operating 177 hydrologic stations on the island because of an unpaid debt of $2 million, thereby shutting down water-quality monitoring.[88] In other words, the closing down of the capacity to assess water quality coincided with the plan to fumigate the island with Naled. The threat of indiscriminate aerial fumigation was tied to a preemptive refusal to assess and keep track of its ecological impacts.

The suit also centered the chemical's capacity to interfere with the health of pregnant women and babies, the figures in the name of whom the Naled program was authored in the first place. Here I quote from it at length:

> Naled is also hazardous to humans as it is toxic, causes serious eye damage, is harmful if inhaled and may cause skin irritation. Also, there have been recent findings linking the presence of organophosphates and behavior problems in babies whose mothers were exposed to this type of chemical during their pregnancy. Also, gestational exposure to several common agricultural pesticides that contain organophosphates, such as Naled, can induce developmental neurotoxicity in humans, and has been associated with developmental delay and autism. As such the CDC's local spokesperson advised, in a radio interview, that he agreed with the P.R. Department of Health's advisory that pregnant women and asthma sufferers must remain inside while spraying, surely exposing the possible effects from direct exposure.

Note the way the case sets up fetal and child harm in Puerto Rico as a possible outcome of the Naled plan, invoking explicitness of place: Chemical vector control promised to save abstract future children from the terrors of a new and wily virus; in practice, however, it was coercive and would expose some Puerto Rican children to chance of chemical harm. Note also that the case implicitly suggests that the US government's broad fear of Zika's intervention in human reproduction had bred a specific chemical management plan that could interfere in human reproduction in Puerto Rico in homologous ways. And finally, note the centrality of possible links between chemical fumigation and developmental delay in future children.

On the back of mounting public outrage over the CDC's concealment and coercion, as well as the lawsuit, Governor García Padilla publicly rejected the Naled program, and as the sun melted into the horizon on July 27, the Puerto Rican Department of Agriculture declared that the CDC would "recall" the 25,000 pounds of Naled slated for aerial fumigation and send it back across the sea to Florida. In August, the CDC notified the Puerto Rican government by email that it would discontinue the Deltamethrin home fumigation program to evaluate the results. WIC director Dana Miró reported that many people "did not cooperate," and because of their lack of cooperation, the fumigation effort was "incomplete or null." With that, the formal chemical vector control plan came to a close, with agricultural, environmental, and medical groups warning everyone to keep an eye out for strange planes streaking across the skies.

On Anthropocene Signals and Hierarchy in Reproduction

The way chemical vector control played out in Puerto Rico bridges contemporary biosecurity practice, empire, the molecular and environmental relations of industrial chemicals, and the enervation of human life in illness and disability. Their convergence in reproductive bodies—not just humans, but mosquito and virus as well—offers important lessons for coming to terms with reproduction's dense and wide net in the twenty-first century, which is at once biochemical, ecological, and historical.

One concerns the relationship between race, sex, and biology in reproduction. The suite of chemical interventions proposed, and in some instances carried out, by US federal agencies speaks to the ways in which some women in some places are made "intervenable," to use Jade Sasser's term.[89] In this chapter I have foregrounded the racialization of Puerto Rico in US law and the long-term chemical accretions of US empire on the archipelago as the context in which chemical interventions were engineered and interpreted, though my insights are not limited to this specific imperial formation. We know that the idea of innate racial difference is a fallacy, but processes of racialization can and do chart material existence in people's bodies: Critical scholars of racist disparities in health and environmental racism have, in various ways, shown how racial hierarchy—and the accretive effects of racism rooted in racial hierarchy—shapes biological existence. Crucially, these effects reach across generations through reproduction. As Shannon Sullivan notes of epigenetic inheritance through genomic imprinting, Anthropocene signals like polychlorinated biphanyls (PCBs), which are used in the produc-

tion of plastics, herbicides, and fungicides, have been linked to problems with the immune system and kidneys in offspring generally, and fertility problems in male offspring specifically. Race is certainly not a biological fact, but racism and empire have biological effects which "help constitute the chemicals, hormones, cells, and fibers of the human body"—and these effects can, via reproduction, be multigenerational.[90]

But acknowledging the capacity of environmental contaminants to shape the human body across generations comes with some serious pitfalls. A key line of resistance to aerial fumigation was the idea that Naled could have some link to developmental delay or autism, positioning these not only as harms to be averted but also as main grounds for striving to avoid the contamination of water systems and human bodies. Thus, even as they called into question the abstract child as silent beneficiary and the reduction of human and environmental health to the prevention of costly microcephaly, the contestations against the plan on health and environmental grounds were tightly linked to fantasies about pure human reproduction and normal bodies and minds. These fantasies are not unique to the case unraveled here. Becky Mansfield and Julie Guthman argue that, even though it renounces genetic determinism, the field of environmental epigenetics lies dangerously close to a eugenic logic that, in training the gaze on improvement, seeks to root out the abnormal.[91] Alexis Shotwell has shown that anti-toxicity politics has a track record of focalizing abnormality in factors like gender/sex distribution, sexual reproduction, and human bodies and minds themselves: Pollutants may produce "gender-bending animals" such as gay and emasculated frogs, dramatically reduce human male birth rates, or cause various forms of disability. She asks why, for instance, investigative reporting on pollution on the Aamjiwnaang Reserve in Canada consistently presents a carnivalesque ratio between girl children and boy children being born, instead of focusing on the long story of genocide, the embodied experience of breathing difficulty, or rates of premature death.[92] Returning to our case, it has been estimated that exposure to organophosphate pesticides, the class of compounds to which Naled belongs, causes the loss of 1.8 million IQ points in each birth cohort of children in the United States, resulting in an annual loss of $44.7 billion in productivity and increases in education and healthcare costs.[93] I find this to be an important attempt to capture the pesticide industry's damage to collective human capacity, very much in line with Carson's work on DDT. I am also unsettled by the presentation of this damage in terms of the standardized intelligence quotient and lost productivity. We must ask the difficult question of why rendering the nexus of reproduction and environmental harm visible beyond the

communities affected by it so often depends on foregrounding "that their kids are born with disabilities and that adults are made disabled," rather than, say, the human pain it causes.[94]

Different narratives of reproduction, which marshal different definitions, timescales, and spaces of health, produce radically different worlds. If we are to begin to rewrite our understandings of reproduction so that they are more ecologically attuned and grounded, it is imperative that the opening up of the narrative to include, for example, the reproduction of water systems, not cement existing hierarchies of human life.

As a final point, one that carries us into the next chapter, the recognition of a densely populated reproductive field must not come at the cost of attention to the distinct ways the humanity of certain groups of women and girls has historically been, and continues to be, reduced to their reproductive capacities as environmental uncertainty froths and foams. Understanding the forms of discipline that accompany the diminishment of full human persons into simple bodily thresholds between the unstable extra-human reproductive formations of the Anthropocene and the future—framed variously in terms of fitness or economic vitality—will be key to interrupting the blaming of women for the inability of state or capital to bring nonhuman reproduction under control and to ending the treatment of them as reproductive trajectories to be managed instead of thinking and feeling subjects.

You can begin to note the tension across these points! I am demanding autonomy in reproduction, positing reproduction as a collective socio-ecological process, and rejecting the reduction of women to this process. There is no clear way out of this tension, but it is clear that this tension is unevenly distributed across space and among lives, as are its consequences. Embedded in a vast, rich, and dynamic web of biological interdependencies on the dynamic geological formation that is Earth, reproduction is cast as a matter of choice and self-actualization for some in privileged social locations, while for others it is aggregated and redirected into questions about limited economic and ecological futures. It is vital that we work through these two readings of reproduction in the years to come, for it is my sense that they are not opposed but are related to each other in complex and consequential ways.

3

(DE)POPULATION
Intervention II, LARC Distribution in Puerto Rico

The intrauterine device (IUD) is made from low-density polyethylene, one of the most common types of plastic in the world. It is T-shaped, and at the base of the T, there is a small loop through which a strand of polyethylene string is doubled. About the size of a quarter, a paperclip, or earbuds, it can sit very snugly in the center of the palm. There are two kinds of IUDs. From its place in the uterus, the hormonal kind steadily releases the synthetic hormone progestin, rendering the body inhospitable to fertilization. The copper kind comes replete with a thin wire tightly wound around the base of the T. That soft, ductile metal, the preferred electrical conductor in telecommunications circuitry and power generation and transmission, incapacitates sperm, stopping them from arriving at an egg.[1] The contraceptive implant is a flexible plastic rod that looks like a matchstick. From its position under the skin of the upper arm, it dispenses progestin into the bloodstream, stopping the body's monthly release of an egg. These apparatuses—the hormonal IUD, the copper IUD, and the contraceptive implant—are known as long-acting reversible contraceptives, or LARCs for short.

The capacity of LARCs to impede reproduction hinges on their embedment inside the body. I can paint a picture of what this embedment entails by blending my own experience of the IUD with medical protocols. Having one placed begins with a series of polite orders punctuated by the entry of different things into the vagina—fingers, a speculum, the plastic T itself, and scissors—all provoking the clenching of the jaw and a sharp intake of breath: *Please take two ibuprofens approximately thirty minutes before your appointment. Please refrain from eating a large meal before your appointment, but please ensure that you are nourished. Please bring a menstrual pad. Please sign this form here, indicating that you do not have an ongoing pelvic infection such as cervical gonorrhea or chlamydia, and that you are not currently pregnant. Please be aware that menstrual cramps and bleeding may increase with the use of an IUD. Please wait until you hear your name called. Please put on the gown, remove your pants and underwear, and step up to the table. Please place your feet in the stirrups. Please relax while I determine the size and position of your uterus with my hands [placing two fingers in the vagina and the other hand on the abdomen]. Please take a deep breath and exhale while I insert the speculum [inserting speculum] and take a look at your cervix [grabbing tenaculum; gripping the anterior lip of the cervix]. Please keep breathing, this will all be over soon. Are you doing OK? Good, I am now going to insert the IUD [opening a small package to reveal a small plastic T and loading it into the insertion tube]. You will feel a quick, sharp pain and then it will be over [pushing the insertion tube through the cervical canal until it finds resistance at the uterine fundus]. There, that was it [removing insertion tube; procuring long-handled scissors]. I am going to trim the strings now [trimming IUD strings]. Please sit there for a moment to make sure you're OK. Are you OK? Good. The bleeding is normal. I am going to step out now, please put your clothes back on, and the menstrual pad you brought. Your IUD can stay in you for up to five years. Moderate bleeding and discomfort are normal in the first three to six months but come see us if you experience anything beyond that. Please book an appointment to remove your IUD if you intend to get pregnant or for any other reason. Do not attempt to remove your IUD without your doctor.*

And I can surmise the process of contraceptive implant insertion, which commences with the question of which arm is the nondominant one, with the same medical protocols: *Please lie down on the table; bend your arm and raise it above your head [putting on gloves, then preparing the upper inner arm, eight centimeters or so above the medial epicondyle of the humerus, with antiseptic wipe and marking a dot]. This might sting a little [injecting a local anesthetic]. There, this part of your arm should now be numb. OK, now I am*

going to insert it [pulling off the cap of the preloaded applicator to reveal the needle]. This should only take a second [inserting the needle into the arm at an angle, then sliding it horizontally underneath the skin to deposit the plastic matchstick]. OK, that's it [clicking the button back to pull the needle back into the applicator and throwing the applicator away]. Can you feel where it is [gently palpating the injected arm with pointer and index fingers]? Touch it. If you feel it move, or if it becomes lost, contact your doctor immediately. Your implant can stay in you for up to three years. Please book an appointment when three years pass or if you intend to get pregnant. Do not try to remove your implant without a doctor.

These kinds of implantations were repeated thousands of times over just more than a year in the Zika Contraceptive Access Network (Z-CAN), the first program to rapidly distribute contraception in a public health emergency and the subject of this chapter. Funded by the CDC's nonprofit arm (CDCF) and the Bill & Melinda Gates Foundation (BMGF), and made possible through the provision of extensive supplies of these diminutive plastic implants at no cost by the pharmaceutical companies that produce them, Z-CAN sought to equip as many women in Puerto Rico as possible with LARCs. The hormonal and copper IUD and the contraceptive implant thus joined the synthetic chemicals examined in the previous chapter as technologies for managing the Zika emergency's unchecked proliferations of virus and mosquito by working on—or rather, *in*—the sexed female body.

To be clear, Z-CAN was not a Zika prevention strategy. Rather, it was a birth aversion strategy, and it was acclaimed throughout its tenure for its cost-effectiveness: The birth of children with Zika-associated microcephaly and all of their care costs across the lifespan could be deterred, forestalled, obviated. Michelle Murphy has posited that the logic of averted birth has constituted a significant portion of the global reproductive health imagination for the last forty years, but how this logic works in practice, and how its styles of population-thinking might be changing under new environmental pressures like Zika, requires deeper thought. In addition to being a principal Zika strategy, LARCs have after all taken on a fundamental role in international family planning of late, including the UN's FP2020, and the plastics from which they are made are a ubiquitous material of everyday life that "exist[s] in geological time."[2] The implantation of small plastic apparatuses in groups of uteruses or arms for national and international public health, economic, or environmental purposes is intelligible to us in the twenty-first century. Why? And with what consequences? I take these questions on in what follows by analyzing the plan to inoculate the United States against Zika's dystopian economic fu-

tures through the provision of LARCs in Puerto Rico, unraveling the science with which it was designed, its unfolding, and its possible long-term effects.

In doing so, I want to break open the hopeful narratives of the Zika virus as a boon to feminism because it generated the funds and public support necessary for free birth control and, in some cases, abortion. A strong caveat is required here: Considering the difficulty that girls especially face in procuring the kind of contraception they might desire, the cultural setting of abstinence-only sexual education in which they are both coerced into sex and socially punished for expressions of sexual agency, and the prevalence of rape, the expansion of access to contraception is a good thing. Moreover, Z-CAN program directors understood that the history of eugenics was important context for their ambitions. I want to honor the program's concrete positive outcomes, especially as the relentless epidemiological surveillance of the sexed female body in other areas of active Zika transmission did not result in more open access to contraceptives.

However, as I have already described here, LARCs are not merely provided. Contraceptive implants are shot underneath the skin, from where they release a steady stream of synthetic hormone, thereby thickening cervical mucus and thinning the lining of the uterus. IUDs are pushed through the cervical canal and embedded in the uterus. The introduction of the speculum—a tool developed from the "speculum oris" used for force-feeding on slave ships[3]—is very uncomfortable, and even with the aid of a swipe of cold lubricant, the introduction of the insertion tube into the cervical canal is a strange accompaniment to the speculum. Implantation itself is a sharp pinch felt deep inside. In a certain sense, these devices become part of the person in whom they are embedded.

Nor is the provision of implants and IUDs merely a donation, as the CDCF and pharmaceutical corporations might have it. I argue that it is wrapped up in a broader non-innocent regime of cost-effectiveness that values care and lives in term of economic debits and credits, a regime which may produce eugenic effects. My task is to take a step back and consider how the rapid, targeted implantation of IUDs and other contraceptive devices within a public health emergency linked up with the historical trend in translating reproduction into economic futures. As will become clear, this trend cannot be separated from the denigration of public infrastructures through austerity nor from the climate disaster, and it speaks to the pitfalls of isolating the body that can do gestational labor from social reproduction in our reproductive imagination.

The Doom of Malthus

As summer turned to fall in 2016, Zika infections in Puerto Rico continued to rise. On this development, and continuing to highlight that the virus was circulating on US ground, *The Atlantic* reported, "America is already experiencing a Zika outbreak. The disease has already infected almost 20,000 American citizens and more than 1,500 pregnant women—with some estimates reaching as high as over 10,000 infected pregnant women. . . . This year's cases are just the beginning, and it looks like the virus could become endemic on American soil in the near future." As Congress went back and forth over whether to allot additional funding for Zika, Puerto Rico was proclaimed to be "at a stage well beyond the reach of a preemptive strike."[4] Following the rejection of aerial Naled fumigation, expert discourse shifted from the immunizing logic of the "preemptive strike" using chemical methods to questions about the cost-effectiveness of alternative methods that could be deployed at other nodes in the emergency's network of reproduction or at other moments in a collective reproductive process. As chapter 1 demonstrated, the potential costs of children born with microcephaly to the US healthcare system were being tabulated ever since scientists declared a concrete link between the virus and microcephaly; now, in the wake of community resistance to covert chemical fumigation, microcephaly's speculative costs would be measured against the cost of methods that would work directly on the human reproductive system itself.

Alongside Zika's proliferation, another storm was brewing. Puerto Rico's $72 billion public debt, introduced in the last chapter, which tied the archipelago to the mainland through finance capital, had weakened local reproductive health infrastructures that could mitigate the chance of microcephaly, whether through supplying birth control, monitoring pregnancies, or providing abortion services. Debt featured prominently in the lexicon of mainland reports on Zika in Puerto Rico at this time, in headlines like "Zika's threats come at a time when Puerto Rico is trying to pay off a massive debt," or "the virus has been yet another blow to a debt-ridden island."[5] Zika intensified the problems of indebted medical infrastructures—the lack of equipment, the outmigration of physicians, the backlog of laboratory analyses, and the power outages in hospitals and clinics—which, in turn, threatened higher reproduction rates of Zika and higher incidences of microcephaly. Zika, sexed female bodies, and debt became intertwined in a number of respects: in public deliberations about what Puerto Rico "owed" finance capital amid a public health

emergency that could spill into the mainland, in discussions of whether it was the debt crisis or Zika that had overwhelmed the Puerto Rican healthcare system, in scholarly estimations of what Puerto Rican Zika babies would cost the US nation and, as we shall see, in the question of whether investments in reproductive healthcare services in Puerto Rico would, in the long run, save money. Their fusion was crucial in sustaining the economized imaginary of reproductive risk and in licensing mass birth control provision as the second key form of Zika intervention that was pursued on the archipelago. So it was that CDC officials declared the population of 138,000 "women of reproductive age (15–44 years)" who did not desire pregnancy but who were not practicing effective contraception—a population that had been delimited earlier in the year—as Z-CAN's target.[6] Let us slow down to consider the trajectory from the research that tabulated women and girls in the form of a mass sexual problem to the proposal of a solution, articulated in the language of cost-effectiveness, in the form of plastic or plastic-and-copper implements to be inserted into their bodies.

Where did the idea of a mass sexual problem come from? It is not enough to answer that question by invoking the Zika emergency, because the sexual conduct and fertility of Puerto Rican women and girls figured prominently in the academic output of US universities and public health institutions long before the diffusion of the virus, with linkages both conceptual and concrete to science and policy. Zika tabulations of Puerto Rican fertility drew on a history of apprehension about overpopulation on the archipelago, which rotated around the working-class woman. In the 1920s and 1930s, she was framed as an enticing sex worker at once beautiful and disease-ridden, and Puerto Rican families as too large because of unrestrained sexuality. Public health journals argued that poverty, crime, prostitution, homelessness, and disease were all the result of overpopulation. Driven by concerns over IQ, heredity, and the specter of national biological decline, researchers examined statistical relationships between birth rate and death rate and between population and food production.[7] This Malthusian-Darwinian ethic was carried into the middle of the century with Puerto Rico as a persistent reference point. *Human Fertility: The Modern Dilemma* (1951) by geneticist, demographer, and eugenicist Robert C. Cook was a major work in the field of population control during this period, and Puerto Rico was one of the places Cook described when he wrote of "unbalanced and unchecked fertility ravaging many lands like a hurricane or a tidal wave"; as such, he advocated a "vigorous" government birth control policy.[8] Kingsley Davis, another important figure in mid-century demography, argued that "for a permanent improvement of living standards in Puerto Rico,

fertility must come down."[9] U.S geographic thought was linked here to reproduction via the "doctrine of nonviability": Puerto Rican sovereignty was not viable due to its small size (space) and lack of natural resources (landscape), geographic obstacles to viability that were made all the more insurmountable by rampant human reproduction, which itself functioned as a climatic or meteorological force. Déborah Berman Santana cites a raft of doctoral dissertations in the discipline that contributed to this perception of the archipelago despite a lack of empirical evidence. A widely circulating textbook, for example, described the archipelago as having incurred the "doom of Malthus."[10] What defined this body of knowledge was its presentation of discrete causal links between Puerto Rican fertility as a force of nature—a wave or a hurricane especially—and all manner of social issues.

In 1955, in her endeavor to develop oral contraceptive pills for women everywhere to ingest, American philanthropist Katherine McCormick called for a "cage of ovulating females to experiment with."[11] The main island of Puerto Rico, hemmed in by stretches of sea, would come to serve as one of those cages. Following norms of clinical research at the time, researchers looked at the island with a "monarch-of-all-that-I-survey" lens and interpreted a bounded space, a group of women who could be effortlessly monitored, and a medical school that had "the American approach."[12] Just as crucially, the Comstock Laws, which prohibited the publication or distribution of "obscene" information, contraception, and contraception research in the United States, did not apply in Puerto Rico, paving the way for researchers to set up the experiment. It was not simply thrust onto a passive, uninformed group of women. Many cooperated, while many dropped out after researchers did not take seriously side effects like lethargy and loss of libido.[13] Finally, when researchers tried to narrow the bars of the island cage to an actual cage, the Women's Correctional Institute at Vega Baja, "resentment on the part of the female prisoners toward the project proved enough to disrupt the discipline of the prison."[14] By 1963, half of the 730 trial participants in Puerto Rico had left the study, amid reports of deaths.[15] The first birth control pill was approved by the Food and Drug Administration largely on the back of these data.[16]

Oscar Lewis's study of a Puerto Rican family that bridged archipelago and mainland, *La Vida: A Puerto Rican Family in the Culture of Poverty* (1967), developed the social scientific concept of a culture of poverty. The book held that disorderly sexuality and mothering styles were the root of Puerto Rican poverty, painting rich portraits of absentee fathers, large families headed by women, fixations on sex, and teenage pregnancy.[17] The culture of poverty provided both data and an interpretive lens for thinkers and policymakers intent

on further delimiting a reproductive root to poverty, overlaying the modern reproductive imagination with the idea of the reproduction of cultures over generations. The fundamental point, though, is that anxiety over women's and girls' sexual conduct and "matrifocal" households is rife in US social scientific knowledge on Puerto Rico, and this knowledge was tightly linked with the changing shape of the US state across the twentieth century.

The influential idea that Puerto Rican women and girls constituted a legitimate population to be intervened in brings me to the foremost historical specter haunting Z-CAN: the sterilization of up to one-third of women in Puerto Rico in the 1970s and 1980s, an experience that demonstrates the endurance of the modern reproductive imagination's eugenicist values well beyond the first half of the twentieth century. Laura Briggs argues that the one-sided narrative of US social control in Puerto Rico through forced sterilization is too simplistic: Many Puerto Rican women had fought to establish birth control clinics; many others actively sought sterilization, whether for financial reasons, health reasons, or beliefs about scientific modernization. Additionally, Briggs shows how the framing of sterilization and birth control as a coordinated genocidal scheme of the US government has shored up traditional ideas of both family and femaleness.[18] Yet two facts remain, and they are relevant to our story: First, even though involuntary eugenic sterilization was never officially ordered (despite the many resounding calls of demographers and food and soil scientists and contraceptive activists), sterilization rates in municipal hospitals in Puerto Rico in the 1970s and 1980s were some of the highest in the world, leading many questions to be raised as to how voluntary the procedures were; and second, population control was the primary lens through which mainland politicians and experts understood the archipelago. These two points, as well as the broader shift in the grammar of population control from ideas of tropical biological difference to one of limited resources and economic development, conditioned LARC provision in Puerto Rico as a Zika intervention.

To this genealogy of expertise on reproduction we can add one final component: much more recent public health research on the sexual behaviors of teenage girls, the statistical starting point for CDC researchers in calculating Zika risk and assessing avenues for intervention. One example was the CDC's reinterpretation of the 2013 Youth Risk Behavior Surveillance System. The survey examined behaviors among teenagers across the United States that could result in morbidity or mortality, centering teenage pregnancy as a negative public health outcome.[19] This survey was especially important in establishing that half of girls aged fifteen to nineteen in Puerto Rico "were assumed

to be sexually experienced" and in highlighting a birth rate that was almost double that of the US mainland. At first glance, this may seem to be a simple citation on the part of CDC researchers in order to establish the number of people who might be affected by Zika. However, the use of data on teenage sexual activity and pregnancy constructed both the problem and the solution that would follow in specific ways.

The dominant perspective on teenage sexuality in the United States combines Freud and Darwin, telescoping the rich range of possible expressions and experiences of human sexuality down to those that could result in pregnancy or disease. (At this point it should go without saying that the "scope" of this telescoping is much narrower for girls than for boys.) Teenage sexuality is commonly understood as a powerful biological drive that will overtake morality and common sense if left unrestrained by "civilizing" forces. The value and social context of adolescence is reduced to biology, which is assumed to both order and disorder teenage life. Laina Bay-Cheng has noted important parallels between the effects of the conflation of hypersexuality and adolescence in twentieth- and twenty-first-century US culture and the conflation of anal sex and homosexuality in eighteenth- and nineteenth-century France on which Michel Foucault worked: In both cases, the interest in sexual behavior gives that behavior an "analytical reality."[20] Stripped down, the Youth Risk Behavior Surveillance System turned human sexuality into a system of classification and marked out the hypersexual Puerto Rican girl's body as a public health concern. Doing so was the first step in positioning that body as an object of public health surveillance and possibly control. For targets of intervention—whether military targets or the population targets of public health agencies—do not merely exist: They must first be produced as targets.

With this long line of demographic, ethnographic, and public health expertise on island reproductive conduct in view, it is plain to see how and why, as Adriana Garriga-López argues, the US government's approach to Zika sexualized teenage girls, stigmatized teenage pregnancies, and produced the adolescent girl's body as the "focal point of control."[21] The chance of mass microcephaly posed by the reproductive nexus of mosquito and virus added another layer of systemic racialized cost to a public culture that already constructed the public costs of teenage pregnancy as high. The utilization of a nationwide survey of "risky" behaviors in Zika science marked out Puerto Rican high school girls as a cause for concern in familiar ways. (Of these girls, CBS Moneywatch declared, "Preventing pregnancy . . . could prove harder than stopping Zika."[22]) The data were available and presented an intuitive choice for researchers because of the track record in US science and public policy of

using the sexed bodies of Puerto Rican women to interpret and explain social inequalities and problems. With this background in mind, I want to turn to the models and metrics employed by CDC researchers to assess the economic viability of mass contraceptive distribution to Puerto Ricans in the time of Zika.

Microcephaly's Metrics

As noted earlier, the examination of population-level surveys about teenage and unintended pregnancy in Puerto Rico led researchers to name a gap in contraceptive use that the problem of Zika demanded be addressed: 138,000 women "of reproductive age." Discussions about filling this gap focused on the promise of LARCs, those methods of contraception deemed "highly effective" for ease of use and long-term placement in the uterus or arm, but employed by less than 1 percent of women in Puerto Rico. What would it cost to increase their usage, and how much money would be saved in doing so?

Through interviews with bureaucrats in the federal agencies operating in Puerto Rico, such as the Centers for Medicare and Medicaid Services and the Office of Population Affairs, along with family planning and reproductive care providers, experts affiliated with the PRDH, Title X federal family planning grantees, and the Puerto Rico Health Insurance Administration, CDC researchers were able to name barriers to LARC use. Perhaps most obviously, the cost of the devices themselves was rarely covered by insurance, private or public (and this says nothing about the cadre of people without health coverage of any kind). They noted that the cost of hormonal IUDs could be as much as $900, and while they in theory could be offered at a lower cost in Puerto Rico's Title X clinics, insertion fees ranged from $100 to $500. Furthermore, acquiring an IUD required women and girls to navigate many different administrative contexts. A Puerto Rican gynecologist explained these contexts to me as follows: "If a doctor writes out a prescription for a woman to get an IUD, it still won't be easy for her to get one, especially if she is going to use her *tarjeta* (health insurance card).[23] The pharmacy could say it isn't covered, so the doctor will have to call the insurance company and explain to the case manager just why she needs an IUD." The permission of both doctor and insurance case manager was therefore required to get an IUD, with the willingness of the former to engage with the latter being especially important. But beyond this fragmented and paternalistic system of acquisition, the devices were scare. They were consistently out of stock at hospitals, Title X family planning clinics, private medical offices, and community health clinics, and only a limited number of care providers were trained in IUD insertion. So

even if a patient could afford the associated fees, and was able to break cultural norms and ask for an IUD, that patient would not necessarily achieve the desired end of IUD implantation in the uterus. Averting microcephaly therefore required both a significant increase in the supply of devices and the training of physicians and nurses who could implant them quickly and at low cost. In a project led by the senior economist of the Division of Reproductive Health, CDC researchers thus turned to testing the cost-effectiveness of increasing the LARC supply and training doctors on the archipelago in LARC care—and it is surely significant that this division, which is in charge of issues of reproductive health, maternal health, and infant health, should employ economists.

One tool they used was the decision tree model. Decision-tree methodology weighs the aggregate financial burdens of clinical interventions against one another, delimitating "a point at which the cost differential makes one decision truly superior to another."[24] The recent rise of decision-tree analysis in local, national, and global healthcare demonstrates the centrality of market logics to contemporary care decision-making, as well as the broader reduction of lives to an economic imprint. The target population of the decision tree was defined as fertile, sexually active women with male partners, not desiring children within a year and not having undergone permanent contraception such as tubal litigation. The tree measured nonintervention against same-day, no-cost provision of contraception; costs included the pills or contraceptive implants themselves, training and compensation of healthcare providers for insertion and removal, and educational materials and media campaigns. The cost of intervention was tabulated at $33.5 million, or $206 for every individual in the target population. A key output measure of the model was the number of microcephaly cases avoided.[25]

The weighing of costs and benefits did not end with cash-in, cash-out arithmetic in the model. In cases where intervention proved costlier than nonintervention, researchers quantified the value of intervention in other ways. Another output measure of the Zika decision tree was healthy life years (HLY) gained. HLY is a metric of population health that functions as a "disability-free life expectancy indicator," and it employs an arithmetic very different from the kind that was commonly used in descriptive epidemiological studies before the 1990s, which looked at brute numbers of deaths resulting from specific diseases.[26] Metrics like HLY try to account for "the impact of diseases and conditions that may not be fatal, but by virtue of their duration and disabling effects contribut[e] to losses in the form of diminished productivity and strain on health systems."[27] The avoidance of microcephaly was translated into the

years of disability-free life that could be gained, increasing economic productivity and reducing healthcare costs. Thus, the purpose of utilizing HLY in the Zika decision tree was to capture how mass birth control provision could optimize the population, even in situations where the model predicted intervention costs to exceed nonintervention costs. Crucially, it captured intervention benefits in a dichotomous financial register of work (good) and public care expenditure (bad).

In the end, the model predicted that averting twenty-five cases of Zika-associated microcephaly in a single year (sixteen of which would have resulted in live births) would save $31.7 million in the most likely scenario. The proposed intervention was deemed cost-saving in 92.11 percent of the model's possible outcomes and cost-effective in 98.1 percent of outcomes. This second figure included the small percentage of outcomes in which intervention would fail to save money in real terms but was still deemed "cost-effective relative to accepted cost-effectiveness thresholds" in adding disability-free years to the population.

These models and metrics configured the relationship between individual and group life, the state, and the future in a very particular way. The HLY metric is similar to the quality adjusted life years (QALY) metric, in which the quality of each year of life is quantified into a "utility" on a scale from 0 (immediate death) to 1 (perfect health), with "utilities" totaled across a lifetime.[28] (The use of the word *utility* here conjures its lay meaning of a state of being useful or profitable to someone or something, as in, for example, the utility of lives to circuits of production and consumption.) However, where the QALY assigns utilities on a sliding scale, HLY slots lives into a 0–1 binary, where 0 signifies disabled and 1 signifies perfect health.[29] Both of these metrics literally devalue years of life lived with disability, not over fear of bodily difference but due to the potential for deductions from the economy. Furthermore, implicit in them is the existence of a point at which investments in healthcare are no longer "worth it." The reason for this is because in decision tree modeling, a financial threshold must be agreed upon at which gaining a single HLY through healthcare intervention is no longer cost-effective in the more expansive sense than dollars in, dollars out. This is the point around which the whole framework operates.

As a final point, the HLY metric, as Katherine Kenny observes of related metrics, "represents an internationally standardized quantum of life measured as a unit of *time*, that is, time as life-years."[30] This is distinct from disease statistics, which discern the prevalence of a disease across the population, and also distinct from vital statistics, which look at the condition of a single body

across a lifetime. HLY measures the optimization of health through future productive time, eschewing lifetimes for "*life/time*, life-as-time."[31] It breaks down lifetimes into units that may be measured and monitored against one another, without—and this is key—stooping to the cultural taboo of ascribing brute dollar values to human life.

Of course, as we saw in chapter 1, brute dollar values *were* recurrently affixed to the Zika baby. However, there is a meaningful distinction between those price tags and the use of the HLY metric in decision tree analysis. The former was brought about by surging concern about immigration control; the latter was enlisted to buttress well-meaning attempts to present mass birth control provision as a worthy investment even if, on the surface, such provision may cost more than the money that would be saved. HLY is an explicit recognition that public or public-private expenditures on healthcare can be worthwhile even if they are expensive. But such metrics add weight to the tyrannical framework of cost-benefit analysis, which Matt Sparke has argued forecloses "ethical invocations of health as a basic human right, replacing them with a de-contextualized and thus methodologically flattened landscape of health services as commodities as metrics."[32]

And it would be a mistake to suggest that this mode of reducing lives to future economic impact is agnostic in terms of race or nation. Its central logic was that the birth of some humans should be averted so that others, in the future, might live more comfortably; without naming race or nation, its cost-benefit analysis set differential adjudications of life worth in place. Z-CAN outreach material promoted LARCs as the favored contraceptive method due to their longevity and ease of use. On the section of the Z-CAN website designed to provide prospective patients with information on available methods, LARCs were paternalistically described under the heading "One time, that's it" (*Una vez y ya*) like so: "If you forget even to eat breakfast, these are the option for you. [LARCs] are long-term and highly effective contraceptive methods. In just one visit you can acquire birth control that can last from three to ten years, depending on the type of IUD you choose. These methods are reversible, so if at some point you want to have children, just visit us and we will remove it. All of these methods [hormonal IUD, nonhormonal IUD, implant] are covered by the Z-CAN program; that is, you don't pay anything."[33] In addition to convenience, however, the IUD was promoted because its effectiveness in preventing conception translated directly into cost-effectiveness at the level of the population through the aversion of costly lives. In the decision tree model, CDC researchers noted the sensitivity of Zika's aggregate future costs to the proportion of Puerto Rican women using highly effective contracep-

tive methods. Every time an individual selected a LARC over another form of birth control, the incidence of unintended pregnancy dropped and, it follows, fewer Zika-associated microcephaly cases would occur in the population.

Whereas the historical episteme helped to construct Zika's reproductive network in the narrow terms of Puerto Rican fertility and sexuality (especially young female sexuality), models and metrics like HLY and decision trees translated the problems of young female sexuality into speculative futures, in which productive time would either be destroyed by the present emergence of many cases of microcephaly or saved by physical interventions into sexed female bodies. In the cost-effectiveness paradigm, LARCs held explicit horizontal (aggregated across the population) and filial or generational (projected forward in time to encompass future lifespans) promises, as well as the implicit utopian promise that the mass avoidance of microcephaly would enable others to live better. Thus, with the wider cast of characters in the Zika public health emergency in mind, we might say this program sought to avert the Puerto Rican Zika baby for the sake of the mythical child.

The Zika Contraception Access Network

The consultations and compilation of surveys of sexual behavior, fertility, and birth control use in the name of the Zika virus became the basis for an on-the-ground intervention. Z-CAN sought to prevent what medical practitioners call "adverse reproductive outcomes" by providing free contraception in public and private clinics across Puerto Rico. LARCs were the focus; the program trained clinical staff in counseling and the insertion and removal of LARCs in single-day sessions. Women were recruited into Z-CAN by doctor recommendations, posters in health centers, Z-CAN community engagement events, or friends or family; a website and Facebook page also provided general information to the curious. Reflecting the centrality of philanthropic-pharmaceutical partnerships in the recent shift to population control in international development, contraceptive devices and pill packs were provided by Merck and Bayer, while the BMGF and Pfizer donated to support the intervention. Funds were channeled through the CDCF, a nonprofit arm of the CDC created by Congress to marshal private-sector resources in support of the CDC's public health mandate. Z-CAN's emergency timescale was reminiscent of what the United Nations Population Fund has called "task-shifting" in its family planning development work: "Task-shifting means moving certain tasks, where appropriate, from doctors or other highly qualified health workers to health workers with shorter training and fewer qualifications. The aim is to make

more efficient use of the available human resources for health."[34] Note how the language of efficiency elides the structural reasons for deficits in fully trained doctors and nurses; note also that greater health risks could accompany the implantation of contraceptive devices by personnel trained quickly in those single-day sessions.

By June 2016, the CDCF had only raised enough money and trained enough doctors to assist seven hundred women. Few of the donated devices had ended up in the uteruses or arms of the target population, bringing the CDCF to call for an additional $20 million to train Puerto Rican doctors in insertion and follow-up care.[35] By August 2016, 102 of the 300 gynecologists on the island had become officially authorized Z-CAN providers. The Puerto Rican Department of Health assumed greater control over the program in April 2017, and by August 2017, more than twenty thousand Puerto Rican women had received contraceptive counseling, with 95 percent of them returning home with a new contraceptive method or supply of oral contraceptives at no cost. The majority (68 percent) chose and received a LARC. Project organizers highlighted that of the more than fourteen thousand people in whom contraceptive devices had been implanted as part of Z-CAN, almost eleven thousand had used condoms, withdrawal, or no method of birth control prior to their counseling by Z-CAN providers.[36]

Amid the proliferation of abstract archipelago-wide tallies of sexually active women and girls, economic futures, and Z-CAN users, the intimate sensations of LARC implantation could easily get lost. Yet the physicality of Z-CAN's principal technology for microcephaly aversion thickens the story of what the program sought to do, as well as hinting at how it could—indeed, how it has—lived beyond the temporal bounds of the public health emergency. LARCs are structured by two simple but critical features: They must be embedded in flesh deep inside the body, whether in the uterus or subcutaneously in the arm, and both that embedment and any removal are supposed to be carried out by physicians. The first feature means that the device may often be situated beyond the physical reach of the patient; the second means that it is subject to the administration of healthcare professionals. For these reasons, Laura Briggs has made the point to always call LARCs "physician-controlled," thereby locating final reproductive control outside the body of the person whose reproductivity is to be controlled by the device. The spatial politics of physician-controlled LARCs means that Z-CAN's well-meaning vision of expanding access to easy, long-term contraception always had the potential to result in fragmented control of participants over their bodies. The locus, scale, and temporality of reproductive control matter.

A key point here is that mass LARC insertion was part of an emergency effort that sought neither to establish nor maintain long-term access to reproductive healthcare for program participants. Funds and personnel were provided for implants to be inserted quickly, and while the reimbursement fee to be paid out to doctors was bundled to allow for both insertion and removal, many reports contradict the program's promise of free and easy LARC removal. Z-CAN's "When in Doubt, Ask" Facebook page, which had amassed a following of more than twenty-five thousand people by 2017, outlined the procedures for having a LARC removed: Return to the same Z-CAN provider, or go to a different one with your Z-CAN identification number in hand. However, conversations among recipients on the page revealed that while many women were satisfied with Z-CAN, many also found it difficult to access removal care. Several recipients posted about being refused removal or charged several hundred dollars for it.

For example, one wrote, "I went to the same doctors that put in my implant for removal, and they told me they were charging me $100 to remove it . . . I didn't pay anything to get it put in . . . I am about to pull it out myself because it's hurting me. I'm crazy to get rid of it." The device of which she wrote, stationed underneath the skin of her upper arm, was Nexplanon, developed by Merck. Its forebear, Implanon, was the device of choice for the UK's Department for International Development to provide contraception to 14.5 million of the world's "poorest women"; it has been widely criticized and in some places (including in the United Kingdom) discontinued for its propensity to disappear inside the body. Nexplanon is distinguished from Implanon by its detectability by X-ray, a technological enhancement that requires access to radiology equipment to address any problems that could arise.[37] Another woman commented that she too had been quoted $100, followed by another who had paid $150 for removal because of side-effects. There was also speculation about whether free device removal hinged on a minimum one-year tenure in their bodies: Many of those posting about prohibitive removal charges prefaced their complaints by saying that they had already had the device for more than a year. "When in Doubt, Ask" acknowledged in April 2018 that women should not have been charged for removal, yet reports of financial barriers continued to be posted. This digital archive is not reflective of the experiences of all participants, nor does it suggest that Z-CAN was unilaterally oppressive. It does, however, point to the compromises participants faced in making decisions over contraception at the same time that their bodies were positioned as sites for adjudicating proximate and distant economic futures.

Likewise, many recipients reported that their original Z-CAN providers had moved from the archipelago to the mainland in 2017, owing in the first instance to austerity, which had resulted in the closures of hundreds of public schools; the skyrocketing of water, gas, electricity, and food prices; the slashing of health benefits and pensions; and the laying off of a great many public-sector workers. Medical institutions were hit especially hard. Major cuts and doctor out-migration—one doctor per day was said to move to the mainland—meant unstaffed clinics, often without electricity. Sparke calls the ever-present grind of ill health under austerity "biological subcitizenship," in which "cost-effective" interventions such as Z-CAN make real but narrow improvements, while leaving "political-economic pathologies" untouched, in many cases preserving them.[38] The "sub-" prefix of this formulation also speaks to the incorporation of Puerto Rican women's bodies into the economic slant of US reproductive politics, in which their possible Zika babies menaced the hypothetical child.

Rote descriptions of infrastructural abandonment, however, do not capture how austerity actually felt or how it reconfigured the rhythms of everyday life. A few scenes from my time in Puerto Rico during the height of Zika concern can help illustrate this. A few weeks after I arrived, and just as the Z-CAN program was really taking off, the main island was enveloped in darkness for three days: A nationwide blackout impacted everyone except for certain businesses and wealthy homes. The fans stopped working, school was canceled, and traffic flows were tense and chaotic in the absence of stoplights. People in San Juan lost basic water service. When the lights went out on Tuesday afternoon, everyone assumed the power loss would be momentary. Then reports came that power would be restored later that evening, but the promised arrival time kept getting pushed back. On the first night, the streets were filled with people sitting around drinking warm beer, bachata and reggaetón blasting out of parked cars with engines running, but the mood started to change in the nights that followed. People were still outside at night, but more out of necessity than for novelty. It was just too dark inside when the sun went down, and without the help of fans, too hot. The power outage dragged on, gathering all social life into its currents: *I heard tomorrow at seven. Well, they got it back over at such-and-such edge of Santurce. We still don't have water, how about you?*

The blackout was at once a symptom of austerity and a foreshadow of its deepening. It was a symptom insofar as the cash-poor, state-run power company Puerto Rico Electric Power Authority (PREPA) began buying energy from two private electric companies that had recently burst on the scene. The

start of the privatization of PREPA rippled off in many directions: In addition to laying off full-time workers and replacing them with subcontractors, administrative and commercial responsibilities were conferred to Banco Popular, a major bank. It was a foreshadow insofar as the blackout entered into debt-related conversations as evidence in favor of fully privatizing electricity. It reminded everyone of the recent Supreme Court rulings that had struck down an already-tenuous archipelago sovereignty—or, as Maritza Stanchich suggested, revealed that sovereignty to have been a farce all along.[39] And finally, it mimicked the sensation of austerity in Puerto Rico: Its primary effect was to make taking care of oneself and others difficult. Its darkness and heat had weight. It made eating and putting kids to bed and tending to ill family members more difficult. It made *social* reproduction more difficult. People in San Juan scrambled for packaged food at Walgreens or fast food at Wendy's, which with the help of private generators shone like oases against inky skies. The dismantling of a single utility impeded a whole range of other infrastructures and forms of labor needed to keep people well.

A few months later, while walking with demonstrators against the financial control board's first meeting, I was struck by the geography of it all. The meeting was closed off from the public. It was held early in the morning at a hotel in Fajardo, a city some thirty miles from San Juan and thus well removed from the ongoing demonstration against the board at the *campamento* (camp). The Hotel Conquistador was a luxury hotel, with a single entrance atop a hill. It was a stormy morning, and bright orange-and-blue barricades and police in rain gear lined the street, blocking entrance into the restricted space of decision-making by those protesting the closure of public schools and cuts to the university system and marching in defense of Puerto Rican healthcare and pensions. The circumscription of the field of Zika analysis and care to unruly wombs in Z-CAN was concomitant with the circumscription of governance over life-making infrastructures to a barricaded luxury hotel and the expansive spatial reach of austerity. I will return to this dynamic shortly, but first we must make a detour through the composition of the devices for reproductive intervention themselves.

Population and the Planet

The supply chain that commentators had in mind when speaking about problems in LARC supply chain management in the early stages of the Z-CAN program—backups in delivery, not enough care providers, IUDs generally not reaching wombs and implants generally not reaching arms—began from the premise

of the devices already having been produced. To truly understand the role of these devices in twenty-first-century life, we have to go further back up that supply chain and consider their actual material constitution. Like many of the reproductive networks we have been tracking, IUD-based and implant-based interventions are symptomatic of a planet flush with substances that have either been created or pulled from the layers of the Earth in industrial processes (usually a combination of the two). Here, instead of errant toxic particles accreting in the reproductive body with unknown consequences, or plastic monomers causing damage as their structures imitate hormones in that body,[40] we have the deliberate emplacement of extracted or created materials inside the sexed body as a way to strategically interrupt reproductive processes.

The frame of the IUD is usually made from polyethylene plastic, the most plentiful variety of consumer plastic today. More specifically, it is low-density polyethylene, which is composed of long and short branches in the plastic's polymer chains, giving the material its characteristic flexibility and low water absorption. This makes it an ideal material for the pervasive plastic grocery bag and for inserting through cervixes and into uteruses: The polymer utilized for IUDs has "outstanding flexibility and environmental stress crack resistance," as well as being a "'clean' grade suitable for medical use."[41] The copper type of IUD also, as you would expect, contains copper, the same mined metal that forms the basis of most appliance, communications, automotive, and power generation wiring, connecting and electrifying the modern world. The hormonal type depends on industrial biochemical synthesis and production. Finally, to render the devices detectable by X-ray, many devices now contain barium sulphate in the molding powder for the plastic frame, a material primarily used in the drilling fluids required for oil and gas exploration.[42]

Each of these components is obtained through sprawling and complicated systems involving the labor of millions of people. The devices at the center of Z-CAN and other similar programs are, in a very real sense, indicative of the longstanding frame of what Amitav Ghosh calls "world-as resource, in which landscapes (or planets) come to be regarded as factories and 'Nature' is seen as subdued and cheap."[43] Amalgamated into tiny little Ts and matchsticks, they circulate globally as disposable commodities, detached from the sites, labor, and consequences of their extraction, and end up implanted in bodies for various ends. Mexican author Valeria Luiselli's work "Agua negra" (black water) expresses the nexus of the world-as-resource and the modern reproductive imagination: A sister considers the expropriation of communal lands; a niece offers that "mining is a form of accumulation, for some, and dispossession, for

everyone else"; while a mother narrates, upon visiting a copper mine in Arizona, that the IUD inside her has made her body into "an excavated mine."[44] This is one way the planetary conjuncture of the Anthropocene registers in an economized reproductive health program like Z-CAN.

A more obvious one was Hurricane Maria, which escalated seemingly overnight from a tropical storm to a category 5 hurricane and replaced Zika in mainland news coverage of life on the archipelago. Climatology tells us that Puerto Rico is located in a climate change "hotspot," with the ramping up of the Atlantic Warm Pool intensifying the likelihood and impact of such storms. But, it must be emphasized, Maria cannot be reduced to the confluence of the oceanic and atmospheric.[45] The storm further destroyed the local life-supporting infrastructures that had been, and were being, decimated by austerity: powerlines not just structurally under-resourced, but gone; hospitals not simply lacking doctors, but gone.[46] Communication networks were down; curfews imposed. Eighty percent of the island's crops were razed by the hurricane, a percentage given even more weight by the fact that, as an inheritance of the Spanish plantation economy and the Jones Act, Puerto Rico already depended on imports for 85 percent of its food supply.[47] One month after the hurricane made landfall, 78 percent of people were still without electricity. Returning now to the spatial dynamics of LARCS in this context of devastation, bundling insertion and removal in physicians' reimbursement for Z-CAN had the consequence of structurally disincentivizing removal by requiring the time-, cash-, and equipment-strapped healthcare providers who remained on the archipelago to see a patient without further compensation. Though the LARCS at the center of Z-CAN were not meant to be permanent, and though many women actively and happily chose them, "physician-controlled long-acting contraceptives are in a sense the technological inheritors of the social impulse embodied by eugenic sterilization in an earlier generation."[48] Viewed in this light, Z-CAN may have eugenic effects.

The chronology here matters: The Z-CAN program wound down in September 2017, the same month the hurricane tore through the archipelago and Puerto Ricans were cruelly abandoned by the first Trump administration in terms of emergency response. Following the relentless drive to count reproductive *bodies*, Maria showcased that *lives* were not being counted: those that had been lost in the hurricane, for example, as well as the number of elderly and disabled people discharged from under-resourced and understaffed hospitals with possibly fatal infections and other ailments—those people that economized understandings of life devalue.[49] Furthermore, Z-CAN's program

of averted birth cannot be extricated from what Naomi Klein has called the "depopulation" of the archipelago, as investors aimed to transform it into a tropical paradise for global elites after the storm. The Federal Emergency Management Agency (FEMA) constructed "airbridges"—transporting Puerto Ricans to the mainland and providing funds for hotels for a few months—in lieu of restoring the electrical grid. Of the "evacuation," Puerto Rican attorney Elizabeth Yeampierre stated, "What they [investors] want is our land, and they don't want our people in it."[50] Post-Maria depopulation adds an additional layer to the reproductive logic of averted birth, as people of all ages were removed from their homeland. Ever-more turbulent climatic forces render that homeland increasingly inhospitable to anyone who must materially depend on it, meaning elites who may come and go as they please are the only ones who can have access to it. Just as climate crisis heightens the struggle for the right to move, so too does it heighten the struggle for the right to dwell.

One thing economized understandings of potential and fetal life in family planning experiments do is focalize the uterus as the site of life-making, and they do so at the expense of social infrastructures required for actually existing children and adults to remain alive and healthy. The field of immediate analysis (and thus the field of potential change in protocol) is delimited as the womb, and the womb (or more accurately, a large group of wombs) serves as the single explanatory frame. Z-CAN functioned as an emergency measure for averting the lifespan costs of microcephaly at the same time as healthcare infrastructures and general conditions for social reproduction in Puerto Rico deteriorated and some women lost control over their reproductivity. Tabulations of sexualized girls multiplied while life-making infrastructures deteriorated and the island was depopulated. Contraceptive implants were framed as a gift that Puerto Rican women could accept by choice, while austerity measures denigrated the commons and FEMA built infrastructures for evacuating the archipelago of ordinary people. Z-CAN's telescoping of the reproductive body cannot be separated from the desertion of the social reproductive body by FEMA and the financial control board.

As such, in this well-meaning and historically informed program that was premised on getting women fitted with LARCs as quickly as possible, the reproductive body was cleaved off from the social reproductive body. The former was the body externally defined by potential for socially threatening pregnancies, a vessel pointed at economic futures; the latter was the living body that supports one's own life and those of others, performing "the activities that sustain human beings as embodied social beings who must not only

eat and sleep but also raise their children, care for their families, and maintain their communities, all while pursuing their hopes for the future."[51] Pluralized, the former was the aggregate of reproductive potential (a population); the latter was the collective or commons, the life force that exceeded the interventions to which people were subjected. Of this force, in the immediate wake of the hurricane, Puerto Rican historian and politician Rafael Bernabe wrote:

> Let's start with the admirable: the reserve of solidarity, of community, of generosity, that lives on in the country despite three decades of neoliberal preaching and practice that pushes the private over the public, competition over collaboration, egoism over the community, immediacy over forethought, fragmentation over democratic integration. I could give dozens of examples: the ride I have been given when walking somewhere for something (for lack of gas), the food I have been given (because I did not have cash), the coffee offered by my neighbors, the use of a borrowed burner to heat something up for my baby to eat, the doctors and healthcare personnel working in a hospital that had run out of electricity (when we had to go to the emergency room the day after the hurricane). There is no doubt that our people understand and feel, despite everything, that human relationships, even among strangers, are more and should be more than the cold bond of cash.[52]

For an Emphatically Social Reproduction

My ambition in this chapter has not been to assess Z-CAN's effectiveness as a reproductive health program. What I have tried to do is move beyond simple judgments about whether it was good, effective, or even desired in a democratic sense, landing instead on the historical significance of the use of LARCs to avert future lives deemed costly. My own fervent support of the fact that women were able to acquire desired forms of birth control coexists with my wariness of the logic of the intervention. I am troubled by government and medical disquiet over the reproductive capacities of women and girls within a culture that denies them agency. I am troubled by the unequal priority given to insertion versus removal at a time when the global system of life-valuation prized the avoidance of microcephaly above all other considerations. I am troubled by the linkage of intrauterine and arm implantations for some women in the present to the economic vitality of others in the receding future. And I am troubled by the enduring logic of working inside the repro-

ductive body as the social reproductive body is simultaneously abandoned by austerity and subjected to anthropogenic climate catastrophes.

This is in many respects yet another recapitulation of the reduction of women to gestation, one that intersects with race, disability, and imperialist stratification. What the case of Z-CAN shows is that relatively new health metrics have linked up with the adjudication of life worth according to future economic contribution in the global politics of reproduction. Such metrics recoup and rework eugenicist concerns and imperatives in all sorts of ways: in, for example, longstanding angst about the reproductivity of women of color in government policy and scientific expertise, the more explicit eugenicist rhetoric of averting disability, the possible eugenic effects of Z-CAN, and its imbrications with tempestuous environmental forcings. A vigilant eye is required to keep tabs on the many new shapes eugenics might take as the Earth heats up and global inequality increases.

It also shows that the abandonment of the social reproductive body is part and parcel of the focalization of the reproductive body in reproductive healthcare experiments. Social reproduction is a hitherto undertheorized aspect in feminist work on economizations of life, and it speaks to the lived reality of being included in target populations. This too warrants further scrutiny, for as we careen through uncertain ecological futures and as discourses about habitable land for humans being limited due to environmental crisis flourish, experts, governments, and private institutions are tinkering with the reproductivity of certain groups of people in new ways. The task moving forward, I think, lies in explicating the relationship between, on the one hand, forced or prohibited biological reproduction (gestational labor) and, on the other, both the operation of the modern conceits of approaching the world as resource and the spectrum of kinds of investments of "human energy in other bodies" that comprise life well lived.[53]

For guidance, we might look to the persistent foregrounding of social reproduction by feminist political organizers that took place alongside the unfolding of the Z-CAN project. The decolonial and anti-capitalist feminist group La Colectiva Feminista en Construcción emerged in the tumult of the debt crisis and regularly contested the deterioration of infrastructures for social reproduction due to austerity measures. Their "feminist brigades" (*brigadas feministas*) sent out food and supplies in the wake of Maria. They demanded redress for the post-hurricane surge of gender-based violence across the archipelago and, having been mocked by the Ricardo Rosselló administration in a leaked WhatsApp chat, were central in the movement that saw him removed from office. Their public activities highlight the inextricability of the

atmospheric, the oceanic, the colonial, and the neoliberal in the ecological crises of the Caribbean and the archipelago. Their work in distributing condoms, encouraging dialogue about sex, and connecting pregnant women with medical support is inextricable from their organizing for social reproduction and climate survival.

4

ON THE CULMINATION OF SPECIES

Intervention III, Genetically Modified Mosquitoes in Brazil

Think back to the statement penned by an epidemiologist just as Zika was declared an emergency: "Love, sex, and babies are the foundation of human existence. Without them the human race ceases to exist. Zika, a virus that few people had heard of a month ago, has suddenly disrupted this normal course of events."[1] This "normal course of events," as I noted in the introduction and have returned to throughout, ascribes a utilitarian significance to sex. It suggests a fundamental link between sex and baby-making that is lubricated by love and contends that this linkage—reproduction—is the bedrock of life. While throughout the preceding chapters I have been finding ways to complicate this picture and explore the ways, new and old, it works to cleave deserving babies off from undeserving babies in a time of great environmental uncertainty, it is now time for me to disclose that it is surely not *entirely* wrong. As evolutionary biologist Lynn Margulis and her son Dorion Sagan note, the persistent human fascination with sex and reproduction is due to their central place in the long history of human life. "Sexual reproduction," they write, "is the fundamental biological process of maintaining and reproducing identity."[2] While we can identify an abundance of ways in which sex

and reproduction and life have recently been stretched and pulled apart (for example, through developments in assisted reproduction technologies and the recorded obliteration of life in recent mass extinctions), and though we can imagine a myriad of futures in which they may become permanently severed (recall the rise of the sterility apocalypse narrative and the science of declining sperm potency), the interest in reproduction as life remains. Perhaps against the backdrop of these real shifts in reproduction, and looking ahead to speculative reproductive vistas, the interest grows.

Alongside its strong connection to life via reproduction, however, sex has a strong connection to death. HIV/AIDS, of course, made a painful link between sex and death, and the biology of cancer shows how unrestricted cellular replication becomes death, but what about sexual reproduction? Here, too, Margulis and Sagan's provocative account, spanning billions of years and reaching from the scale of the subcellular organelle to the cosmos, is instructive. They describe the first living bodies as essentially immortal, continuously generating copies of themselves. The evolution of sexually reproducing organisms, about a billion years ago, was in a sense also the evolution of individual biological existence, and by extension the evolution of that existence's passing. Individuals ineluctably die. As they write, "sex cyclically produces bodies from fused sex cells through embryo formation, childhood, and adolescence. But this individual form of material organization is limited. Each of us inevitably ages and dies.... Sex both inaugurates and seals our fate as individuals."[3] Sexual reproduction and death have a tense but very close relationship, and this closeness does register in the relatively contracted timescales of human history. The affiliation of sex with "the Fall" in the Judeo-Christian tradition, for example, bespeaks the affiliation between sexual reproduction and the death of sexual bodies. On the face of it, sexual reproduction spells life, but upon close inspection of both the early history of multicellular life and some keystone stories of Western thought, it also very much spells death.

This chapter explores the peculiar alliance between sex, reproduction, and death more literally, in a scene of technoscientific optimism enfolded in the climate crisis's penchant for expanding mosquito populations. I look at three technologies for diminishing Zika's reproduction rate and averting microcephaly that, up until a few years ago, were not scientifically possible: the Oxitec mosquitoes with which we are already familiar, Wolbachia mosquitoes, and mosquitoes modified with gene drives. The first and third involve the direct alteration of genes using biotechnology, and therefore fit into that contentious category of genetic engineering, while the second hinges on the artificial inoculation of mosquitoes with the common bacterium Wolbachia.

Each of these innovations was funded by the Bill & Melinda Gates Foundation (BMGF) as well as other organizations, and worked by programming *Aedes* reproduction for death. In concrete terms, they transformed the reproductive outcomes of the mosquito through subcellular interventions in order to shield human life from Zika's threatened reconfiguration of human reproductive outcomes. More abstractly, we can think of them as displacing the uncomfortable association between sexual reproduction and death onto another species, one which threatens human life as a disease vector and whose distribution has, with global heating, swelled in the last two decades and is projected to continue to do so in the future.

The Oxitec, Wolbachia, and gene drive mosquitoes owe their existence to recent advances in the life sciences, which have allowed intervention into reproduction at the cellular and subcellular levels. Dolly the sheep, produced from an adult nonreproductive cell, was the first mammal to be cloned. The twin girls Lulu and Nana, born in 2018, were the first genome-edited babies, made resistant to certain strains of HIV; the announcement of their birth led the WHO to call for an end to all human genome editing, as well as to the incarceration of biophysicist He Jiankui.[4] (And lest the last example be rolled into a singular narrative about unethical Chinese experiments, it is important to note that Jiankui was trained at Rice University, making it also a story of US universities.) "Proliferating reproductive technologies, along with genomic reshufflings of biomatter in such practices as cloning," Stefan Helmreich writes, "have unwound the facts of life."[5] People have been selectively breeding plants and animals for thousands of years, but only since the 1970s has it been possible to genetically engineer individual organisms. What distinguishes the technologies at the center of this chapter is the proposition and realization of genetically engineering *entire populations*. This is a subset of the emergent and rapidly expanding field of synthetic biology, which has enjoyed a forty-fold increase in funding *since 2016*.[6]

Two points of clarification about the engineering of entire populations as a public health intervention are immediately necessary. First, the boundaries around the population are rarely known because the altered organisms are not confined to the labs or factories where they are created, but are instead released into the world. They interact with the wild types of their species as well as with other animals, they shape ecologies, and they become part of human communities too. And they move and travel: We can speculate about their geographical range and can analyze it with various tools, but we cannot be sure of it. Second, and more importantly, their genetically engineered traits are designed not only for the organisms under the microscope but for

their offspring as well. The objective is to produce intergenerational effects; the main effect of the intervention can only be realized through reproduction. Tinkering with the mosquito genome or artificially inoculating mosquitoes with bacteria can prevent the maturation of their offspring's eggs or produce offspring that will die before reaching adulthood or enable a modified trait of some kind to spread through the entire population. Because they work on future generations, Oxitec, Wolbachia, and gene drive mosquitoes are all premised in some way on the colonies bred in the laboratory producing much more widespread genetic modification of mosquito populations, reaching out to the neighborhood, the city, the region, and perhaps the whole world.

Some believe the modification of the mosquito carriers of dangerous illnesses is a utopian project that represents the future of public health; for others, it is a nightmarish scene of tampering with evolution's natural course. The Zika emergency supercharged these conversations, serving as a compelling case for genetic engineering approaches to global health and translating into justification for future action. A book-length report on possible futures published by the Academies of Sciences, Engineering, and Medicine's Committee on Gene Drive Research in Non-Human Organisms noted that the arrival of the Zika virus in 2016 precipitated all kinds of public discussions about "whether mosquitoes in general should be eliminated—those that are annoying as well as those that pose public health threats."[7] What are we to make of this dabbling in regional exterminations and this flirtation with the idea of wholesale, deliberate extinction at the height of the sixth great extinction? And what does this tell us about the changing shape of reproduction?

I approach these big questions by explaining first how the technologies work, particularly in relation to the Zika emergency. This means delving into the political economy of genetically modified mosquitoes, as well as exploring how they became part of, and in their cyborgian animality continued to produce, the uneven human geographies of global health, development, and patriarchy. I move around a sprawling network of intergovernmental organizations, university labs and spinoff companies, factories, and field test sites and locate the vast sums of public research funding and private capital that sustain them. But what is more, because these projects each in their own way bend the rules of classical evolutionary theory while at the same time subscribing to its logic of persistent improvement, they also give me cause to rethink ideas of sexual reproduction, heredity, and extinction that come to us from the key architects of the modern reproductive imagination. The geologist Charles Lyell postulated how species become extinct in his 1832 book *Principles of Geology*, which influenced Charles Darwin's famous theory of

evolution; my title for this chapter inverts *On the Origin of Species* by speaking to the possible termination of a particular life-form. Gregor Mendel illustrated how different traits were passed down in reproduction through the vehicle of a particulate, stable piece of hereditary material that would later be named the gene. Francis Galton made use of all these ideas in elaborating a eugenicist platform of race improvement. As I will show, as a new mode of artificial selection yoked to natural selection, modified mosquitoes recapitulate these earlier ideas about sexual reproduction and extinction, which were saturated in race science. Mosquito reproductivity is seen as open to manipulation in much the same way as certain groups of reproductive women were, all in the service of improvement and future comfort for some.

In coming to terms with how the Oxitec, Wolbachia, and gene drive projects work, I want to be clear from the outset about two things. The first is that, while these approaches to public health are in their infancy, the consensus so far in the pilot studies for Oxitec and Wolbachia has been overwhelmingly positive. For people living with the daily realities of the Zika virus, as well as dengue and yellow fever, modified mosquitoes can be a tremendous boon: They reduce populations of the dangerous (and annoying) insects without, so far, any known side effects. The embrace of both Oxitec and Wolbachia mosquitoes by the communities that hosted their first field tests is not to be discounted. The second is that these projects also carry a lot of potential for releasing women from the blame for Zika that we have been tracing across the previous chapters, because they decouple the sexed female body from reproduction and open up novel understandings of reproduction itself—understandings that may be necessary for charting better ways of living and dying together on a planet of extremes. Here, I think, we can follow Elizabeth Grosz's lead. Her creative reading of Darwin pulls out a "subtle and complex critique of both essentialism and teleology" that is omitted in popular accounts of evolution as the perfection of the dominant.[8] I take seriously the possibility that modified mosquitoes, and what Eben Kirksey would call their "love stories," can help pry open some cracks in the modern reproductive imagination.[9] For the science and its attendant romances are dazzling in their own right, serving as a powerful justification for corporate biology's approach to the problems of the twenty-first century but also opening up new vistas of reproductive thought.

If these two caveats seem to be at odds with my objective of illustrating the enfoldment of modified mosquitoes in the philanthrocapitalist logic of market-based technological hacks and their elaboration of a submerged logic of instrumental extinction, that is precisely the point. There are no easy an-

swers here; I want to carefully consider whether the immediate concrete public health benefits and the imaginative philosophical benefits of these new love stories are rendered secondary, or even insignificant, in comparison to their crowding out of grassroots public health initiatives or their proximity to the logic of instrumental extinction in the age of the Anthropocene extinction.

New Experiments in Instrumental Extinction

Death by Design: Oxitec's Friendly™ Mosquitoes

Oxitec's mosquitoes are a lot like OncoMouse™, the first-ever patented animal about which Donna Haraway wrote near the turn of the new millennium. She considered the genetically modified mouse products, which were aimed at improving human health, as "imploded germinal entities, densely packed condensations of worlds, shocked into being from the force of the implosion of the natural and the artificial, nature and culture, subject and object, machine and organic body, money and lives, narrative and reality."[10]

Friendly™ mosquitoes have a similar "academic corporate family" as OncoMouse™ as well.[11] They were created by the British biotech firm Oxitec, an Oxford University spinoff company that has specialized in "living insecticides" since its 2002 founding. Although its research and development is still based in Oxfordshire, the company was acquired in 2015 by the US biotech firm Intrexon—whose tagline is "Better DNA"—and then by US biotech investment portfolio manager Third Security in 2020. Throughout its short history Oxitec has received financial backing from the BMGF as well as other global health agencies. The mosquitoes themselves buzzed into the spotlight when Luke Alphey, one of the firm's cofounders, announced at the 2010 annual conference of the American Society for Tropical Medicine and Hygiene that a field experiment had been conducted in the Cayman Islands. Though the experiment had been approved by the Cayman government, the announcement caused a stir, and considerations about transparency and risk eventually found a platform in the UK Parliament.[12] Oxitec stood by the experiment, foregrounding sex: because it was only male mosquitoes that were manipulated and released—recall the mechanism of sex selection carried out in the factory—and because male mosquitoes do not feed on humans, the chance that they would negatively affect people was low. Following the Cayman tests, Oxitec conducted pilot studies in collaboration with the University of São Paulo in Juazeiro and Jacobina in Bahia between 2011 and 2015. There, the Friendlies diminished the wild *Aedes aegypti* population by more than 90 percent.[13]

The point on sex raises the need for a short recap on the operation of the Oxitec mosquito: The Friendly is a male mosquito that has been fitted with a self-limiting gene. When released, it mates with wild females, and the resulting offspring either die before they reach adulthood (and therefore before they can sexually reproduce) or produce eggs that will not mature (therefore foreclosing the genesis of a further generation). The Friendlies' friendliness, therefore, is reserved for humans; to its own offspring, it is deadly. The self-limiting gene hinges reproduction to death, and though Oxitec has not suggested that the product should be used in this way, taken to its logical conclusion, said gene hinges reproduction to species extinction.

The program in Piracicaba with which I opened this book covered an area with more than sixty thousand residents and was underway when the newly dangerous mutation of Zika emerged. Zika heightened the stakes of this program, originally designed to target malaria and dengue fever, and brought worldwide attention on the population-suppressing Friendly mosquitoes, and while a potent internet rumor linked Zika's mutation and the explosion of cases of microcephaly in 2015 to the early pilot studies in Bahia, most residents appeared to be thankful for the suppression of mosquito populations in their neighborhoods.[14] In February 2016, the same month the WHO named Zika a public health emergency of international concern, it released a statement of support for the Oxitec field trials in the struggle against the virus, stating, "Given the magnitude of the Zika crisis, the WHO encourages affected countries and their partners to boost the use of both old and new approaches to mosquito control as the most immediate line of defense." The agency's Vector Control Advisory Group (VCAG) soon held up "mosquito control through genetic manipulation," embodied in the first-generation Friendlies, as a potential key tool for controlling the virus and essential to its long-term vision for global health.[15]

Though the VCAG stopped short of sanctioning full-scale deployment, their nominal seal of approval exemplified how, due to Zika, genetic population engineering for public health was mainstreamed. Questions about regulation never went away, of course, and they had a distinct geography. In the United States, where tests were proposed for the Florida Keys, the Oxitec insect's regulatory journey started under the auspices of the Food and Drug Administration (FDA), but during Zika the burden of assessment was turned over to the EPA. The rationale for the change in jurisdiction was that the mosquitoes functioned more like a pesticide (unleashed on the world) than a drug (ingested and processed by the human body). On the back of this recategorization, Oxitec and various commentators argued that the mosqui-

toes could replace synthetic chemical pesticides and, it follows, render the measuring of different environmental, health, and reproductive risks against each other null; others claimed that humans should not be playing God by tampering with mosquito DNA. In Brazil, by contrast, such questions were much less abstract, turning on concrete matters of safety, efficacy, and experiences of mosquito-borne illnesses. There, field tests proceeded during the public health emergency.

Research for Oxitec's second generation Friendly further developed the linkage between sex and death. The resulting product, a male, would produce three kinds of offspring upon mating with a "wild-type female target insect." Female progeny would die, making the insects "male selecting" in function. Half of the male progeny would carry the self-limiting gene, and the other half would carry genes that made them especially susceptible to chemical insecticides. One important feature of this generation was the fact that the self-limiting trait would decrease in each subsequent generation of male mosquitoes, up to ten generations, such that any unforeseen interactions between gene and environment would be reined in by the reduction of the gene until it no longer existed in the area. The self-limiting gene, in other words, had a limiting function at the level of the individual organism and at the level of the population; also, over time, it limited the inheritance of the gene itself. This collection of updates meant a more potent, and thus more cost-effective, population-suppressing product with a built-in mitigation feature.[16]

Further field tests explored the possibility of releasing Friendlies into Brazilian cities through packets of eggs dropped into small recyclable boxes set about the city, which only required water to activate the reproductive chain required to suppress urban mosquito populations. In contrast to the earlier model, which required the mosquitoes to be produced in a local factory and then released by scientists circulating about the city in vans, the egg packets could be produced in facilities elsewhere and then "shipped, stored, and deployed on demand without expert staff or equipment."[17] In September 2017, Intrexon's CEO Randal Kirk joined UK Prime Minister Theresa May to announce plans (and attract funding) for Oxitec's first centralized egg production unit in Oxfordshire, which aimed to increase egg production twenty-fold, to a billion eggs per week. Seen as a beacon of excellence for Britain's future economic growth, this egg production unit added USD $9.5 million of investment to the $182 million in investments since Oxitec was purchased by Intrexon in 2015.[18] Thus, during and immediately following the formally declared Zika public health emergency, investment in, regulatory approvals for, and deployments of Oxitec's Friendly mosquitoes expanded immensely. A

sprawling geography of modified mosquito reproduction took shape, secured in 2020 with Brazil's biosafety authority CTNBio granting full approval for the Friendly egg packets.[19]

A Really Good Sterility Agent: Wolbachia Bacterium

Another tool recommended by the WHO's VCAG at the beginning of the emergency was Wolbachia, which impedes Zika from turning mosquitoes into host organisms for its own reproduction. Wolbachia-based Zika intervention did not involve genetically engineering mosquitoes per se; the technology was actually much simpler: Infect mosquitoes with the bacterium, which naturally infects a large percentage of the world's insects. Yet the deliberate injection of *Aedes aegypti* with Wolbachia constituted a new technoscientific horizon because of its capacity to alter future generations of entire populations of mosquitoes. The technology turned on the bacterium's role as a reproductive parasite, "an organism that manipulates the sex lives of its hosts to further its own ends," and in particular, as we shall see, its unique strategy of feminization to do so.[20]

This very common genus of bacteria is defined by its reproductive behavior. Like other parasites, it reproduces only via host organisms, but there is an added factor: Wolbachia reproduces within a host organism's eggs. What this means is that its reproduction depends on the reproductive success of female hosts. As science writer Ed Yong puts it, "Females are its ticket to the future; males are an evolutionary dead end." Wolbachia's reliance on female hosts for its own futurity has propelled the bacterium, across generations, to develop strategies to swell the supply of female hosts and constrict, or outright eliminate, male ones. The bacterium has produced, among other curiosities, populations of asexual, female wasps able to clone themselves, it has turned male wood lice into female wood lice by meddling in hormone production, and it has tried to exterminate male embryos of the blue-moon butterfly so that female embryos would dramatically exceed male ones. In host species in which male embryos do survive, Wolbachia still finds ways to intervene. Cytoplasmic incompatibility renders host sperm unable to fertilize host eggs unless those eggs carry the same strain of the bacterium. By changing the sperm in this way, Wolbachia grants infected female insects an evolutionary advantage over their noninfected counterparts; the latter are only able to successfully mate with males without Wolbachia, while the former can mate with all males.[21] Generation across generation, female insect carriers of Wolbachia multiply (along with the Wolbachia itself, of course). The bacterium inhabits a dual position that is at first glance paradoxical: ever-multiplying yet also,

in the words of mosquito biologist and scientific regulatory authority Nigel Beebe, "a really good sterility agent [because] it doesn't affect the fitness of the mosquito very much."[22]

Wolbachia does not naturally inhabit the *Aedes aegypti* mosquito, so the use of Wolbachia to transform these mosquitoes from disease-spreader to disease-suppressor required intervention. Specifically, a species jump had to be made. In 2006, after much trial and error, a research team succeeded in injecting Wolbachia directly into a tiny *Aedes aegypti* egg. A new alliance was created, not by a chance encounter or mutation that across evolutionary time would establish itself as dominant in a population or species, but rather by a microscopic needle tipped with the bacterium and inserted gingerly into a single insect gamete. Through the support of the Vector-Based Control of Transmission: Discovery Research program of the BMGF, a strain of Wolbachia-bearing *Aedes* was born.

But why infect mosquitoes with Wolbachia in the first place? When researchers in Australia started to feed Wolbachia-carrying mosquitoes blood that had been laced with dengue, they noticed that the dengue failed to continue along its path of replication and become established in the body of the mosquito. When they tried injecting dengue cells directly into the gut of the mosquito, Wolbachia arrested viral replication again. It seemed that, among its other unique faculties, the bacteria halted the reproduction of many dangerous viruses. Following the awarding of a "negligible" risk assessment by the Australian government's Commonwealth Scientific and Industrial Research Organization in 2010, dengue field experiments began in the suburbs of Cairns in 2011. It only took a few months after the release of 300,000 inoculated insects for Wolbachia to be found in more than 80 percent of mosquitoes in the area and for local dengue rates to have dropped dramatically.[23] Thus, though they don't carry Oxitec's cheerful trademark, Wolbachia-infected mosquitoes are friendly in the same way. A Wolbachia infection shortens the lifespan of a mosquito, reducing both her chances for reproduction and the number of humans she may bite, as well as bestowing upon her a resistance to infections of dengue, chikungunya, and Zika. Together with its work as a reproductive parasite, Wolbachia's capacity to impede insects from playing host to certain diseases meant that it would simultaneously expunge diseases from a given area. The reproduction of Wolbachia meant the reduction of the disease reproduction rate.

The ground was laid for addressing Zika with Wolbachia-inoculated mosquitoes early in 2016 when the BMGF provided $40 million for research.[24] The World Mosquito Program (WMP) received a large portion of these funds, as

well as additional funding from the UK-based Wellcome Trust, the US Agency for International Development, and the UK government. Previously called the Eliminate Dengue Program, the WMP is a group of nonprofit companies owned by Monash University (Melbourne, Australia) that focuses on "easing the [disease] burden for thousands of communities at risk" through "collaboration and innovation."[25] Zika funding set in motion plans for the large-scale production and release of Wolbachia mosquitoes in Brazil and Colombia (as well as cementing the dengue program in Indonesia and opening up new mosquito control programs in the Pacific Islands). By 2018, the WMP was receiving $125 million annually from the BMGF.

Like the Oxitec mosquitoes, the transformation of Wolbachia mosquitoes from disease vectors to disease obstacles started in the factory-laboratory, where they were inoculated with Wolbachia. The WMP breeds and sustains populations of Wolbachia-infected *Aedes aegypti*, then some of them—it only takes a few—are let loose in "target locations" to reproduce. According to the authors of a study that modeled Wolbachia-based interventions for Zika, "Releasing Wolbachia-infected male mosquitoes can reduce the number of infections by cytoplasmic incompatibility, male killing, and the reduced [disease] transmission ability."[26] The result is that, when Wolbachia makes its way through wild *Aedes* populations, the bacterium becomes established in more than 90 percent of mosquitoes, for all intents and purposes, indefinitely.[27]

Luisa Reis Castro's ethnographic work describes how the WMP program rolled out in Rio de Janeiro in 2018, when global interest in Zika had subsided but it remained a major concern for Brazil's public health authorities. Modified mosquitoes were stored in plastic tubes that were packed into crates and loaded into small vans. Each tube contained 150 Wolbachia-infected mosquitoes, which were released by health surveillance agents in designated spots throughout the sprawling metropolis each week, according to a route drawn by an app. In addition to mapped mosquito releases, the WMP organized educational endeavors in local schools, providing teachers with boxes filled with Wolbachia-infected *Aedes* eggs for students to water and witness their growth through the life cycle. Throughout, there was tension over whether the project was being led locally or by "the Australians" at the helm of the WMP, who would simply leave should some unforeseen reproductive outcome arise. After having spent decades trying to kill as many mosquitoes as possible, Brazil's sudden turn to adding to the mosquito population surely seemed strange to those tasked with their delivery and to the schoolchildren activating their eggs.[28]

Normally, as we have established, Zika's reproduction rate rises when mosquitoes are available as vectors and environments are conducive to mosquito sex. Human sexual transmission is far less common than transmission via *Aedes*. As the WMP explained on its website, a normal mosquito will transmit Zika if it bites a person who has the virus and then goes on to bite another that is not carrying the virus. Wolbachia-infected mosquitoes mostly stop this kind of transmission: If this mosquito bites a person with Zika, the next person it bites does not become infected with the virus.[29] The modification of *Aedes* populations with Wolbachia as a public health technique therefore did not aim to reduce mosquito populations per se but to reduce the viral reproduction rate. On the surface, this feature of the Wolbachia experiment distinguished it from Oxitec's effort. The latter project bonded reproduction to extinction; the former just toyed with, and integrated disease suppression into, the reproductive process. The latter had the potential to turn reproduction's inherent generativity into species destruction; the former just added Wolbachia and stirred. But is this actually the case? Claudia Rivera-Amarillo argues that, in fact, Wolbachia mosquitoes evoke an "old association between feminism and extinction," by which she means male fears over feminists orchestrating an end to humanity via the withdrawal of gestational labor. In this association, which appears in a softer hue in discussions of feminism causing various demographic collapses, the bacterium "appears as savior and destroyer at the same time."[30] Let that provocation simmer as we turn to the dreams for mosquito modification that have yet to be realized.

Super-Mendelian Inheritance: Gene Drive Technology

For some scientists, the use of the Wolbachia bacterium to manipulate the reproductive trajectories of *Aedes aegypti* demonstrated the feasibility of using a much more ambitious technology to bring Zika under control: gene drives. Though at the time of writing a gene drive intervention into Zika had not been carried out, the emergency raised scientific and public interest in the gene drive as a legitimate public health intervention. It also raised, at least in principle, the possibility of taking control over evolution and producing a deliberate species extinction. Maybe mosquitoes could be obliterated from the planet altogether. Gene drives are a new vista in public health, but as will become clear, their logic of reproductive intervention toward the shaping of future populations is also a throwback to the heyday of the eugenics movement.

Scientists have been aware of "selfish" genetic elements for more than a century. The idea refers not to Richard Dawkins's neo-Darwinist thesis popularized in the 1970s, in which "the selfish gene" referred to all genes in

evolution, but instead to genetic material that seems to break the rules of recombination, passing down to all or most of an organism's descendants instead of just a percentage of them. Such material has been described variously as "outlaw," "self-promoting," and "ultra-selfish."[31] In the 1960s and 1970s, proposals to rein in mosquito populations by breeding mosquitoes for genes that encourage male sex determination (remember, only female *Aedes* require blood to reproduce and therefore bite humans), and by yoking selfish genetic elements to genes for disease resistance, were first articulated in scientific literature.[32] In a now-famous 2003 paper, Austin Burt articulated the dream of the gene drive as it works today, while the innovation of the cheap and easy-to-use CRISPR/Cas9 tool for genome editing made it possible.[33]

Gene drive technology controverts the central principle of variation in sexual reproduction. Normally, a parent organism will pass on a particular gene to only some of their descendants, but with a perfectly functioning gene drive, all descendants will inherit that gene, from generation to generation to generation. Like the Oxitec and Wolbachia experiments, gene drives are modifications that transcend individual organisms; if let loose, they transform entire populations and possibly entire species. It is worth highlighting that gene drive technology does not stop at altering or amending genomes; crucially, it also incorporates "a sort of molecular Xerox machine into the mosquitoes' chromosomes . . . [that] causes the edited genes to be copied onto a second of a mosquito's two chromosomes."[34] Early gene drive experiments in 2015 showed that edited genes were passed down to more than 90 percent of offspring[35]—less than the 100 percent rate that would have occurred if the drive had worked exactly as intended but a much larger share of genetic transmission than normally occurs.

So, just as Zika was developing into a worldwide emergency, this new technology was demonstrating that the rules of evolution could be broken. It suddenly became possible to distort the system of recombined inheritance. "Gene drive systems that enable super-Mendelian inheritance have the potential to modify insect populations over a timeframe of a few years," wrote a research team based at Imperial College London.[36] They are the most controversial and least licensed for testing of the public health interventions I have been describing.

Zika's disruption of the story of human reproduction injected urgency into conversations about the potential of gene drives to create a future free of mosquito-borne diseases, and moved these conversations from the realm of niche, if controversial, scientific research to global public culture. As Anthony James, a molecular biologist working on the technology, noted when

the WHO declared the emergency, "Four weeks ago we were trying to justify why we are doing this. Now they are saying, 'Get the lead out.'"[37]

In contrast to their authorization of Oxitec and Wolbachia mosquitoes, major public health agencies like the WHO did not promote gene drives as a possible Zika techno-fix. Responses within the scientific community to both shocking new papers describing successful gene drive experiments and their potential application to the growing problem of Zika—news of both arriving around the same time—were optimistic but measured. The Committee on Gene Drive Research in Non-Human Organisms, for example, argued that "there is insufficient evidence at this time to support the release of gene-drive-modified organisms into the environment," but also conceded that "the potential benefits of gene drives for basic and applied research are significant and justify proceeding with laboratory research and highly controlled field trials."[38] Indeed, this technology's express reworking of the rules of inheritance makes it more efficient than the Oxitec approach (because it requires the release of fewer modified mosquitoes) and more effective (because evolving resistance to gene drives would be difficult). With both rhetorical and financial support from the BMGF, the lead had indeed gotten out. At a conference of the American Society for Microbiology in June 2016, Bill Gates spoke of his desire to eradicate malaria and Zika and suggested that gene drives "over the next three to five years will be developed in a form that will be extremely beneficial for knocking down mosquito populations."[39] In fact, Gates has been outspoken in his faith in mosquito eradication as a pathway to disease eradication, and he doubled his foundation's funding for gene drive research during the summer of Zika to $75 million in the largest ever financial contribution to gene drive technology. Target Malaria, which is not only concerned with malaria, is the Gates-funded project based at Imperial College London that has been working on the sterility form of mosquito gene drives which could, according to the *MIT Technology Review*, "push these species to extinction."[40]

There were different kinds of proposals for using a gene drive in mosquitoes to stem Zika and other diseases. One suggested incorporating a drive into a gene to render mosquitoes resistant to the virus and watch as it spread through reproduction to the entire population. This would work to address a single disease like Zika, of course, but more ambitious techno-optimists pointed out that there were ways to engender a more expansive public health gene drive. One such proposal, for instance, called for a drive that would make mosquitoes sterile. This latching of reproduction to sterility may seem oxymoronic: How could a sterility gene spread through a given population? The modified gene that causes infertility would be located on the X chro-

mosome, so female offspring would receive two copies while male offspring would only receive one. Here, the infertility gene would be recessive, meaning that, following basic Mendelian genetics, two copies of said gene (one from each parent) would be necessary for producing an infertile offspring. Female mosquitoes with only one copy of this gene would remain fertile but carry the infertility gene and spread it to all their offspring.[41] A third plan would attempt to "spread a genetic payload" through the population, a set of "instructions" if you will, that in sexual recombination would produce only male descendants. Across each generation, the number of females would diminish until there were none left, making reproduction impossible.[42] The gene for sex selection had been delimited in 2015; experimental plans for linking that to a gene drive were now in the works. This proposal positioned maleness as central to contending with mosquito-borne illnesses.[43] But the most important point is that the latter two proposals—the one utilizing the infertility gene and the other utilizing the sex selection gene—were designed with extermination in mind. They would, at least in theory, result in the obliteration of the mosquito population.

I say in theory because a real-world field test of gene-drive-modified mosquitoes has not yet been conducted. Due to their potency in pushing genetic changes through populations and their capacity to beget extinction, all research with gene-drive-modified organisms has proceeded in high-security labs that seal off the space of reproductive experimentalism from the wider world with multiple doors. Yet tentative but burgeoning endorsements by the global health establishment suggest that the interventions I have explained here, which couple mosquito reproduction to extermination, will continue to be identified as cost-effective, chemical-free solutions. Crucially, in 2020, the WHO released guidance for standards in modified mosquito research and development; the organization acknowledged the "urgent need [for] innovative approaches to help control mosquito-borne diseases," highlighting modified mosquitoes as "one such approach, but we want to be sure it's fully and responsibly evaluated."[44] Criteria for how to bring gene drive field tests out of the lab were included, paving the way for this purest of expressions of the utopian promises, and dystopian pitfalls, of the yoking of mosquito reproduction to mosquito death to be actualized.

Rewriting the Rules of Reproduction (or, Darwin and Mendel in the Twenty-First Century)

One of the contentions I have been building across this book is the need for refurbished understandings of reproduction in the twenty-first century, and the Oxitec, Wolbachia, and gene drive mosquitoes indeed provide glimpses in that direction. Scientific attempts to instrumentalize evolution toward disease eradication demonstrate the enduring influence of the modern reproductive imagination, but they also confound it, pointing toward new, and perhaps even workable, ways of conceiving reproduction, inheritance, and relation.

We can start with how these experiments break the rules of Mendelian inheritance, which have until recently been understood as unbreakable, and confound the idea of competitive struggle, which has retained a firm grasp on understandings of reproduction since Darwin spelled it out in *Origin*. (The fervent opposition to including evolution in school curricula, not unrelated to resistance over the provision of comprehensive sexual education to the same children, should not be taken as evidence of Darwin's theory's lack of influence, but rather of its enduring position at the core of debates about human relationships and humanity's place in nature.) Competitive struggle, as we have already had occasion to note, is part and parcel of the modern reproductive imaginary. In Darwin's theory, both individuals and species have a propensity for proliferation, which meets the limits of environment in terms of both scarcity and hostility. As Elizabeth Grosz argues, "This proliferative superabundance can be understood, more negatively, as the struggle for existence, in which this superabundance drives species and individuals to compete with each other for increasingly limited resources."[45] The struggle for existence, then, pits organisms (which have a tendency to expand and multiply) against one another for resources (which have a complementary tendency toward diminution and depletion). The environmental arena of competitive struggle was linked to the laws of inheritance Mendel developed in his pea plant breeding experiments with the aid of Darwin's writing. Classical Mendelianism holds that the character of an organism is determined by discrete hereditary units which are entirely separate from any sort of environmental influence and which remain stable through sexual reproduction. These units (now understood as the different alleles of a gene) are independently sorted into gametes and then recombined through sex between individual organisms—but across these processes of assortment and recombination, the units themselves are not altered in any way. They are understood, in fact, to "reappear in the next several generations unchanged, in definite numerical ratio."[46] At

the scale of the individual organism, Mendelian inheritance positions biological ancestry as determinative in character, as well as positing kinship as a tree in which biological essences are transmitted (or not) from generation to generation.

The struggle for existence meets these laws of inheritance in the question of which genes make it more or less likely for an organism to successfully reproduce. A key feature of sexual reproduction is that it involves the procurement of better combinations, "a shuffling of genetic information," as Margulis and Sagan note, "that sometimes leads, as in a game of cards, to a more effective combination—the biological equivalent of a better hand."[47] This is what biologists call the heterozygote advantage. Sexual reproduction, via which genetic information is shuffled, can produce fitter organisms that are better able to compete in the environmental arena.

At their base, the mosquito modification projects conform to these classical ideas. All three intend for lab mosquitoes to go out and engage in the struggle to reproduce before dying. And because the Oxitec and gene drive mosquitoes are genetically modified organisms, they are premised on the transmission of modified genes to descendants in sexual reproduction's rearrangement of genetic information. However, gene drives in particular contravene Mendelian laws of inheritance, hence the common reference to "super-Mendelian inheritance" in scientific journals and reporting. In 2015, science writer Sharon Begley narrated the shock the first publications on gene drive experiments sent through the research world, studies which would go on to enable the drawing up of plans for gene-drive-based Zika interventions. Initially, a team that created gene drives in yeast achieved more than 99 percent inheritance of a particular gene; then another a group of researchers used a gene drive to force a gene for yellow pigmentation to be inherited by all the fruit flies in their study. Begley noted that while turning a group of lab flies yellow of course sounds harmless, the implications of gene drives potentially "hijacking evolution" are monumental for the modern reproductive imagination. Of the dominant understanding, she writes, "For more than a century, geneticists have known that, in organisms that pair up to reproduce, most genes have a 50–50 chance of being inherited, as Gregor Mendel famously showed in the nineteenth century with pea plants. Thanks to Mendelian inheritance, offspring carry either mom's or dad's version of the gene for, say, digesting lactose. Similarly, evolutionary biologists have known since Charles Darwin that natural selection eliminates inherited traits that reduce organisms' fitness, such as mosquitoes' susceptibility to the insecticide DDT." Gene drives, she continues, "can outsmart both Mendel and Darwin," requiring a

gene to be inherited by many more descendent organisms, across many generations, than is possible under conventional genetics and natural selection.[48]

In requiring a given trait to be passed along in sexual reproduction, gene drives violate the principle of genetic shuffling. Chance, which Darwin argued sits at the center of evolution, is lost. So too is the link between chance and competitive struggle: It is at this juncture where a case could be made for our modified mosquitoes causing us to rethink the dominant reproductive imaginary. In the case of gene drives, whether a trait is passed on does not hinge on an individual organism's successful competition in an environment of limited resources or, at the level of natural selection, a trait's generalized utility in the reproductive process. Instead, it simply is always passed on. If Darwin's understandings of laissez-faire capitalism and imperial struggle were reflected in his understandings of reproduction in nature, and if government officials and technocrats hungry for scientific justifications for exploitation and violence amplified those understandings in the enduring paradigm of social Darwinism, the gene drive's disruption of the competitive element diverges from the modern reproductive imaginary in a profound way. (However, I would also hypothesize that as global inequality hardens and large technology corporations accrue power to a degree similar to that of the feudal lords of the past, the loss of chance and competion here reflect something of a new feudal world order in which things are already decided.)[49]

Another way these experiments chart a divergent course of reproductive thought from the modern reproductive imagination is in terms of sex and gender. It is well established that in elaborating his theory of natural selection, Darwin saw, alongside imperial domination and capitalism, Victorian gender ideals at play in the natural world around him. In *The Descent of Man* (1871) Darwin developed the argument that males who prove successful in competitive struggle are the ones that will be able to fertilize more, and more desirable, females. His theory of sexual selection holds that females tend to do the choosing, and victorious males are those with the most offspring. Competitive struggle, in other words, is foundational to relationships between men and women.

Owing to the strong grip the idea of competition has on the modern reproductive imaginary, we can find repetitions of Darwin's understanding of sex and gender in the Oxitec, Wolbachia, and gene drive experiments. Reis Castro's work describes how the Wolbachia project was narrated as a system that runs on its own: "We release these mosquitoes, and nature does its part."[50] What the project managers meant by *nature* was the relentless male drive to compete and copulate, and we can turn to the Oxitec product for the

full elaboration of this premise. Among the many characteristics for which the Oxitec product has been celebrated is its capacity to penetrate the domestic sphere, one of *Aedes aegypti*'s favorite places to be. This stands in contrast to traditional insecticides, which can only be unleashed in homes via a robust course of chemical spraying and either require people's cooperation or have to be carried out coercively, as we saw in chapter 2. The Oxitec mosquito, a male programmed for population death, would always find a way into the home because of its drive to mate. As Hadyn Parry, CEO of Oxitec, told *Nature*, "The male mosquito will always find the female. It doesn't have to ask permission to enter the house."[51] In fact, the plight of the male Oxitec insects was often narrated in the terms of a Greek or Elizabethan tragedy: Because of the manipulations to their DNA, they would only live a few days, and any offspring they produce in that clipped lifespan would fail to develop into sexually viable adults, yet they "will spend their lives competing, copulating, and, because they are so numerous, overwhelming the population of wild males in the pursuit of females."[52] Curiously, some otherwise excellent reporting on the Oxitec experiment in Brazil sourced incorrect information on how *Aedes aegypti* reproduce in order to conform to the dominant picture of ruthless male competition for reproduction. Like many other insect species, male *Aedes aegypti* do equip females with sufficient sperm for the rest of their lives, but unlike the common fruit fly and other mosquito species, they do *not* fill females with a sperm plug that "blocks competing sperm." *Aegypti* males do play dirty to prevent additional rounds of fertilization in other ways—by transmitting proteins—but it is worth reflecting on the journalist's decision to run with the evocative but erroneous image of the sperm plug in depicting the Oxitec experiment.[53] All of this is to say that portrayals of the sexual conduct of the mutant mosquitoes have abided by the prevailing image of competitive male struggle for access to females.

But they have also turned that image on its head. These experiments—their depiction in science and culture, and their actual alterations to the reproductive process—defy the modern reproductive imagination's tidy definitions of and associations between the sexes and, the case can be made, the inexorable focalization of the sexed female body as the site of reproductive intervention. Pause for a moment over their rooting in the significant transformation of the internal workings of the *male* body in order to transform the reproductive process at large. Manipulation of the male scales up to manipulation of the population. This is a significant deviation from the modern history of reproductive intervention: While men's sexuality vis-à-vis procreation has been understood in all sorts of ways, the responsibility for modifying the body to

prevent pregnancy has overwhelmingly been borne by women. The vasectomy, a surgical procedure in which the vasa deferentia are cut and sealed off to block sperm from getting into the urethra—and, consequently, block sperm from being able to enter another's body during sex—is the major exception to this disparity. Now widely seen as an elective form of permanent contraception, the procedure was first popularized as part of the eugenics campaign in the United States in the early twentieth century.[54] By dint of its use of the sexed male body as the site of intervention for molding and shaping a wider population, the eugenic vasectomy is a peculiar precursor to the mosquito modification projects; both are deviations from the dominant collapsing of a dense, interdependent reproductive process onto the sexed female body.

The reworking of the relationship between insect sex and reproduction also provides a quick peek into a world in which women entirely command the means of reproduction. As I have explained, the Wolbachia Zika project turned on feminization. The scientific minutiae of Wolbachia reproduction have been translated into the cultural terms of "taking control" and "extreme feminism," with the bacterium itself painted as a "male killer." Hinting at the rendering of males as obsolete for reproduction, the term *immaculate conception* appears frequently in descriptions of Wolbachia.[55] Begley's article "Who Needs Males, Anyway?" points to a fact that might be uncomfortable for men, and one that adds to anxieties about male uselessness that are rife in fascist, incel, and other antifeminist cultures today: It is not only strange bacteria species like Wolbachia that can produce immaculate conceptions—that is, reproduce without males—but also most groups of invertebrates and even some vertebrates.[56] Though her piece is meant to be playful (and argues that, due to the plenitude of deactivated genes, male-free reproduction would not be viable for mammalian life), it is an example that strays from the popular Darwinian vision of reproduction as coy and choosy female birds being wooed by the most beautiful male birds. Darwin himself knew about this kind of reproduction and wrote about how curious it was that, given its existence, some species require the enjoinment of two separate sexual beings to reproduce; I am not interested in his understanding per se, but rather in the popular reproductive imagination, and here the Wolbachia project makes two interesting and related moves. As with the other mosquito modification projects, it displaces the burden of managing Zika's broad social problems from reproductive women and girls onto reproductive insects. And it interjects into insect reproduction a bacterium whose evolutionary interests are served by the production of new female insects. Taken together, these are suggestive of a feminine seizing of control over both the actual means of reproduction and

the culture of reproduction. Many writers have focused on male killing as one of Wolbachia's modus operandi, but in my view the softer form of the bacteria's capacity to feminize (cytoplasmic incompatibility) is a more interesting starting point for thought. It speaks to the mutability of sex and gender in relation to reproduction and alludes to the possibility of simply turning beings feminine. But of course, the opposite is the intent of some of the plans drawn up for gene drives: In seeking to push a genetic payload that results in only male offspring through the population, the drive's obliteration of the mosquito populations starts with the obliteration of females.[57]

Love Stories and Instrumental Extinction

Let's return to the matter of inheritance. One of the concerns raised by these respective experiments was the potential for horizontal gene transfer, which is the movement of genetic material laterally, from species to species, instead of vertically from parent to offspring. As one journalist asked of the Oxitec mosquitoes, "What if the mosquitoes end up transferring their altered genes horizontally—to other non-target species, rather than just to their own offspring?"[58] Since the 1950s it has been accepted that bacteria can exchange bits of DNA across species boundaries, and in the ensuing decades, lab work on infectious diseases revealed that genes that coded for resistance to antibiotics could, and regularly did, spread horizontally. That the use of one antibiotic, whose target was a specific, defined bacterium, gave rise to resistance across many different species of bacteria could not be explained by the given reproductive paradigm of random mutations and vertical inheritance.[59]

While concerns about horizontal gene transfer were first raised when news of the deployment of Oxitec mosquitoes broke, it has been Wolbachia that has served as the key site of contemporary rumination about horizontal gene transfer beyond the world of single-celled organisms. An important 2005 study registered the presence of DNA from Wolbachia in the genome of the fly species *Drosophila ananassae*. Given Wolbachia's penchant for hopping species to expand its own prospects for reproduction, the research team assumed the DNA came from living Wolbachia inside the fly, but after an experiment with antibiotics and similar investigations into the genomes of wasps and mosquitoes, they concluded that Wolbachia DNA had transferred to all these species. Between 20 and 50 percent of insect species have Wolbachia DNA written into their own genomes. Wolbachia evinces both the fact of genes being transferred from bacteria to animals and the ubiquity of this occurrence, and a growing body of work suggests that a significant portion of

animal genomes have been acquired through lateral transfer from bacteria or fungi.[60] Not only are sequences of bacterial DNA mobile; they can jump species, genera, and kingdoms.

At first glance, the biological reality of horizontal gene transfer challenges Darwinian understandings of reproduction, or at least those currents of Darwin's work that have been popularized across the last century and a half. In Darwinism, sex is a thing that happens between male and female organisms of the same species, which is an outcome of success in a wider arena of scarcity and competition. Only the fittest members of the species reproduce. The theory of natural selection takes organisms—and by extension their genetically associated families, kinds, and species—as discrete entities of and for reproduction. By contrast, horizontal gene transfer is an ever-present reproductive process in which genetic material that is not of either parent organism becomes part of the genetic profile of the organism in question. It is a "flowing" of genes "through the biosphere, as in a global organism," in the words of microbiologists Fernando de la Cruz and Julian Davies.[61] This interspecies form of genetic transfer does not abide by the sex binary or the two-parent model. And it is a mode of reproduction in which "what an organism is, and whether something is part of an organism or not" are open questions.[62]

On one hand then, Wolbachia's penchant for engaging in horizontal gene transfer certainly cracks the modern reproductive imagination's edifice. "Charles Darwin was narrow-minded when it came to thinking about sex and love," Eben Kirksey observes regarding the bacterium's confounding of the rubric of competition and species discreteness in Darwinist understandings of reproduction, as well as of the wider cultural workings of heterosexism. His take is that Wolbachia "interrupt evolutionary accounts that attribute a functional significance to sex."[63]

However, horizontal gene transfer is not a simple repudiation of the vertical model of reproduction. In her work on antibiotic resistance, Hannah Landecker asserts that horizontal gene transfer and vertical sexual reproduction "are not opposed, but are intersecting modes of proliferation over space and time." This is important: Once laterally transferred stretches of DNA are incorporated into new genomes, they can mutate, and through sexual reproduction, they recombine and can be inherited. As Landecker makes clear, "new DNA is kept and reproduced through cell division if it aids in the survival and proliferation of both the genetic mobile element and the bacterium."[64] This is as much the case in practice as in theory. When concerns were raised over the possibility of horizontal gene transfer occurring through mosquito-modification-based Zika intervention, they centered on the poten-

tial for horizontal transfer to other animals, perhaps to a large predator or even to a human, as well as to the environment, in such a way that they could affect future generations.[65] Could, for example, Wolbachia move into, and impact, people during mosquitoes' blood meals? If so, what effect could their genes have now or in the future? Horizontal gene transfer displaces neither vertical reproduction nor Darwin's competitive struggle.

Zakiyyah Iman Jackson has observed that in elaborating creative theories of mutualism in evolution, Lynn Margulis and Dorion Sagan utilize the racist language of miscegenation to describe, in the lexicon of the Harlequin romance, "forbidden couplings" between microbes and genomes. Such a maneuver, she notes, ironically augments a "homology and symbiosis of 'race' and 'species,'" a dynamic I see in this embryonic but exigent area of biotech research and product design as well.[66] Kirksey argues that Wolbachia's "love stories" can help break down "filial divisions along lines of race, class, and nationality to generate new queer kinship networks."[67] The bacterium's route to breaking these down is through its cutting of the link between sex, reproduction, and futurity, an unraveling we have been following in all three of the mosquito modification projects. Kirksey considers Wolbachia akin to queer barebacking culture, in which the knowing exchange of HIV establishes meaningful forms of kinship around dying, instead of around the generation of new humans. Central to his claim that Wolbachia and queer barebacking violate the primacy of the filial is another claim: that human sex resulting in procreation is "becoming increasingly problematic" due to the number of people on the planet, expressed in his ominous but contextless projection of the human population growing to eleven billion by 2100. Thus, running through his explication of "new and promiscuous convivial associations" is an antinatalism, which due to its links with the ugly history of population control, reinscribes race, class, and nationality back into his narrative. For that matter, the way the reproductivity of these mosquitoes was seen as open to manipulation was, to borrow a term from both evolutionary and developmental biology, and to further riff on Jackson, *homologous* to the way the reproductivity of certain groups of women was viewed in chapters 2 and 3.

Looking at the Zika response across these different sites, we might say that within the general menace that nonhuman reproduction posed to human reproduction was a more specific interchangeability, that between an intervenable reproductive inhumanity that was insect and an intervenable reproductive inhumanity that was assigned by place, race, nation, and cost. We might also correlate deliberate mosquito extinction here with conservation, whose acute intercessions into the lives of certain prized endangered species

are pursued while restrictions on the burning of fossil fuels, the deindustrialization and diversification of agriculture, or the redistribution of land are not. Such interventions are irrevocably reproductive and intensely gendered. Juno Salazar Parreñas tells the story of the orangutan Lisbet, who would have to endure "forced copulation for conservation" if she failed a rehabilitation program on Borneo: "She would be assigned to the captive breeding program. Once sexually mature at about fourteen years old, she would be temporarily confined with a male orangutan for the purpose of impregnation.... A few months after birth, the infant would be taken away, even though orangutan infants usually stay with their mothers for about seven years, learning how to survive." Both Darwin's exacting female fauna and the limiting frame of liberal feminism are cleverly encoded in her conclusion that this style of reproduction "does not take 'female choice' into account."[68]

A similar reinscription was also evident in regulatory conversations and funding. When major public health organizations articulated the promise of modified mosquitoes for Zika control, the terms of discussion had in many ways already been set, and one of the main coordinates was climate change. That is, mosquito-borne diseases that were once understood as indelibly tropical were, because of the expanded geographic reach of *Aedes aegypti* and *Aedes albopictus* mosquitoes, global. Making a measured call for the regulatory approval of the Oxitec insects in 2009, for example, molecular entomologist Paul Eggleston reported to the WHO, "The problem isn't going to go away. Global warming is having a real impact, with the encroachment of mosquito-borne diseases on southern Europe."[69] The choice of the word *encroachment* positioned Europe as a region in which *Aedes* does not belong, reviving long-standing fears over the porosity of temperate geographies to the tropical. The language of encroachment was expressed regionally too: In Colombia, for example, *Aedes aegypti* was imagined to be "climbing the mountain," propelled by heat from low-lying, tropical regions (racialized as Black) to mountainous Andean regions (racialized as white).[70] Mosquito modification experiments in Brazil were seen as a sort of on-the-ground test case for possible futures of *Aedes* over-reproduction in the United States and Europe and possible technical solutions for that over-reproduction. Wolbachia-inoculated mosquitoes were first trialed in Australia, but the international practitioners of the WMP project in Rio de Janeiro viewed the city as an important laboratory to test what lies ahead for cities in the Global North, as well as a crucial site of data capture: "it was Rio—with its recurrent outbreaks and its alarmingly high number of cases—where the approach could have more meaningful results, yielding clear and more tangible epidemiological data."[71] It appears that it was

heat's specific rewriting of given geographic distinctions between temperate and tropical, North and South, overdeveloped and developing, more than a desire for the elimination of mosquito-borne illnesses, that prompted global support for modified mosquito trials.

Indeed, the raucous novelty of the reproduction found in modified mosquitoes must be seen as part of the global geography of philanthrocapitalism, in which the charities of Silicon Valley billionaires drive global health research agendas and fund a significant percentage of the budgets of major public health authorities, most notably the WHO, as well as dictating how that money is spent. Each of the three mosquito modification projects was funded by the BMGF, among other influential organizations; and the ones that have been field-tested, Oxitec and Wolbachia, were later endorsed by the WHO. The BMGF emphasizes experimental technology and innovation in its approach to global health: Producing novel technical solutions is its objective, not primary care or disease prevention. Oxitec and Wolbachia mosquitoes were both funded by the foundation's Grand Challenge research scheme, which aims to "foster innovation to solve key health and development problems"[72]—but excludes research on issues of "priority, access to health interventions, and delivery systems."[73] As such, it is important to ask whether evaluating and funding projects on the basis of the Gates Foundation's core values is the most effective and ethical way to address a problem like Zika. The foundation famously has "donor darlings"—diseases such as polio, toward which enormous resources are directed to eradicate—and which reflect the desires of its billionaire overseers, not the needs and priorities of target communities.[74]

In this context, the desire for disease eradication, which joins the twentieth-century lineage of the Rockefeller Foundation, is worth pausing over, for it is indicative of the philanthrocapitalist approach to health and it returns us to the matter of reproduction in a roundabout way. The prospect of eradicating Zika—of engendering Zika *extinction*, of bringing about the *cessation of its replication* in an absolute, global way—was raised in the swirl of research and innovation around these projects. For example, one study on the cost-effectiveness of releasing Wolbachia-inoculated mosquitoes devised both a deterministic model and a stochastic model to look at reproduction rates of Zika. It used a long string of abstract mathematical equations that broke down different kinds of *Aedes* and moments of *Aedes* development in the reproductive process—aquatic stage (that is, not sexually mature), wild male, wild female susceptible to Wolbachia, wild female exposed to Wolbachia, wild female infected with Wolbachia, and Wolbachia-infected male—to argue that the intervention would render conditions "sufficient . . . for the extinction of Zika."[75]

Part and parcel of the political economy of these experiments in reproduction is the conflict between billionaires' lofty, placeless desire for disease extinction through innovation and the grounded, immediate tasks of local control and care. To consider Zika an engineering problem made the framing of genetic engineering innovations the principal and most efficient route to its solution. As Nancy Stepan argues, the project of bringing about the extinction of a disease is a wholly modern idea.[76] It is a totalizing one too: Operating on the assumptions of material independence from the world and of that world being a laboratory, it reflects the Silicon Valley elite's hunger for controlling nature and forestalling death with technoscience, "imagining life as a distended present, suspended from time and shielded from decay or change."[77]

With this in mind, let's consider the elevation of the twentieth-century desire for disease eradication to the twenty-first-century desire for mosquito eradication. Each of the Oxitec, Wolbachia, and gene-drive-modified mosquitoes dips a toe in the idea of purposeful mosquito extinction. Oxitec markets its insect-product as "population replacing," but its true aim is to radically reduce insect populations, and its linkage of sex to death indicates, if not a practical commercial end, then at least a logical end to mosquitoes. Wolbachia-inoculated mosquitoes are not as explicitly linked to extinction, but their multipronged destruction of maleness conjures the old affiliation between feminism as taking over control of the means of reproduction and feminism as ending reproduction. Although, as Claire Colebrook notes, feminism has tried to name and confront world-annihilating politics like nuclear war and environmental breakdown, the association between feminism and extinction endures[78]—and Wolbachia mosquitoes similarly link sex and reproduction to death. Gene drive mosquitoes, not yet tested in any real-world setting and not endorsed by major public health organizations, would take this linkage even further. In a contribution to a synthetic biology text on gene drive mosquitoes and Zika, scholar of science and risk communication David Berube argued, "Species-cide is the engineering of extinction of an entire species. [Gene drive approaches to Zika] could result in the collapse of the entire population of a species of mosquito. There is nothing sinister about extinction. Species go extinct all the time."[79] Perhaps it is for these reasons that Bill Gates has, in addition to writing about mosquitoes as the "deadliest animal in the world," made a point of highlighting that no other animal, *not even humans*, kills more people.[80]

A key element of the rationale for deliberate mosquito extinction was time, specifically, the speeding up of evolutionary time. Evolution, as we know, produces changes to species across timespans that exceed the lifespans of indi-

vidual organisms. Speeding up or slowing down the process has been a major issue for those trying to manage populations for various ends. Sven Lindqvist argues that at the heart of twentieth-century European thought on humanity was "the conviction that 'inferior races' were by nature condemned to extinction: the true compassion of the superior races consisted in helping them on the way."[81] The figureheads of the eugenics movement, most notably Galton, argued that avoiding the extinction of animals and humans depended on helping evolution along by improving "hereditary factors." Both the withholding of healthcare and genocide could be accepted as part of twinned processes of progress and extinction in this reasoning; life-supporting infrastructures would allow the wrong kinds of people to reproduce and slow down the progress of evolution. While it is clear that mosquitoes are not doomed to extinction by virtue of their inferiority or their lack of fitness for modern civilization—they have flourished in the last several hundred years, and even more so in the last few decades—they join the poor women in the Global South as beings that are reproducing too much and therefore in need of intervention according to the dominant understanding of reproduction in the Anthropocene.

Time figured centrally in mosquito manipulation too. The mathematical Wolbachia model mentioned earlier provided the condition for the extinction of Zika, yes, but through the reduction of the reproduction rate; it shortened the time for mosquito extinction, making it a cost-effective public health tool. One of the main arguments for the field-testing and ultimate approval of gene-drive-based mosquito extinction is that by tricking the rules of inheritance, they speed up evolutionary time by removing the contingency of genetic recombination. Inserting sterility genes into mosquito embryos and letting them spread through the population naturally would not be practical. It was their dramatic speeding up of evolution that made these projects cost-effective, and thus an ideal site of philanthrocapitalist investment.

Of course, not everything can be controlled by the dyad of innovation and cost-effectiveness. In the end, things did not go according to plan in an Oxitec study in Jacobina, Brazil, mostly conducted prior to the emergence of Zika and originally cited as evidence of the potential for the Friendly mosquitoes to be enlisted successfully in the fight against Zika. It turned out that, despite Oxitec's harnessing of mosquito reproduction to population death, some of the mosquitoes that resulted from the union of modified males and wild females not only survived, but also produced offspring that reached sexual maturity themselves. The lines between the modified and the wild became blurred; bits of the genomes of the modified insects were inherited. Oxitec had been

clear from the start that death was not inevitable. But that between 5 and 60 percent of living local mosquitoes had inherited some Oxitec DNA was not expected.[82] Yet, notwithstanding this lack of control in practice, the desire for profit and for control among philanthrocapitalists remains firm, and it's difficult to imagine this desire cohabiting with more socially and ecologically just reproductive imaginations.

On the Eugenic Futures of Environmental Crisis

I began this chapter by pointing to a central feature of modified mosquitoes for Zika control: In them, the ties between sex, reproduction, and life are severed, with sex and reproduction becoming yoked to death instead. It is now time to qualify that point with two more by way of closing. The first is that, in all this talk of death, we cannot lose sight of what we have established in the preceding chapters: that Zika intervention projects were pointed toward the protection of only certain future children. Of course there were other logics at play: innovation as an end as well as a means, cost-effectiveness, and capital accumulation, for instance. But the fortification of possible future children—a fortification I have identified as selective and as sometimes pitting possible future children against one another—underpinned these logics at the same time as it pasted the faces of future children onto them. While these experiments all, in their distinct ways, scrambled the modern reproductive imagination's circuitry of sex, gender, relation, and inheritance, that scrambling was enlisted in the service of cementing the position of the future deserving child. If the modern reproductive imagination should suffer further and deeper fractures as it undergoes stress testing from various forms of environmental upheaval, it is plausible that that stress and pressure could be displaced onto another species in order to maintain the integrity of its core logics. Perhaps this is a case of a particular, bounded reproductive form being reconfigured so that the imagination as a whole, as it were, could remain intact. The point, though, is a simple one: Mosquito manipulation was for the benefit of some children.

The second is that, even though they trafficked in the logics and imagery of evolution in the natural world, these projects were profoundly artificial in the basic way that Darwin understood the term: Traits were selected by an outside source, not by potential mates and not by the long and expansive process of natural selection. Because they started with human meddling, the mosquito modification projects are better considered experiments in artificial selection than glimpses into the confounding of natural selection as process and as concept. As such, they seem to me to be as much a new iteration of

livestock breeding or forced sterilization as an unprecedented experiment in genetic engineering, and the artificiality of the selection process begs the question of what the criteria for judgment are. The linking of artificial selection to natural selection in the unleashing of the factory- or lab-created insects in neighborhoods in Brazilian cities is, of course, novel, as are the promises and pitfalls of engineering entire insect populations. What I am trying to say is that, like many of the reproductive forms I have been unraveling in this book, mosquito modification is both strange to us and familiar, both very new and very old. It is strange and new in its innovative plays on the manipulation of reproductive living-being at the molecular scale through the editing of genes and the orchestration of a species jump. Yet, what is familiar and old is the outside manipulation of reproductive living-being for some sort of instrumental ends.

Amitav Ghosh has argued that one of modernity's central myths is that human life is entirely detached from material dependence on the planet.[83] In my judgment, these projects reflect an enduring allegiance to that myth as they develop a Silicon Valley brand of eugenics. Think about how, amid persistent shortages in funding for local public and women's healthcare infrastructures, billionaires fund "a macho solution that entails sending male mosquitoes to impregnate as many females as possible, with the ultimate ambition of wiping the enemy off the face of the Earth."[84] That solution cannot be isolated from the unnecessary conditions of ill health of all kinds produced by austerity. Think also about the absence of attention to nonhuman life as something other than just a substrate for progress in corporate biology's discussions about mosquito extinction. Missing are the frogs, spiders, fish, or birds that might rely on mosquitoes for food, for example, and more broadly, the worlds of consciousness lost when a species goes extinct by design or otherwise. (I am reminded of the question Rachel Carson posed a few years before she died of cancer: "Who has decided—who has the *right* to decide—for the countless legions of people who were not consulted that the supreme value is a world without insects, even though it be also a sterile world ungraced by the curving wing of a bird in flight?"[85]) And think about how mosquito population engineering flouts the contingencies of the sexual encounter and genetic recombination and mirrors the thresholding logic we have been following. What are we to make of these technoscientific elaborations of the premise that some should die so that others in the future may flourish? And what is lost by the fact that the major proportion of funding available worldwide for addressing environmental health problems like Zika is geared toward reproductive engineering of this ilk?

Answering these questions requires not losing track of the enfoldment of the development and deployment of such reproductive innovations within a reproductive interdependency that is at one social and ecological. Brazilian-Italian photojournalist Dado Galdieri's profile of Zika in Recife, several years on from the initial outbreak that catalyzed the declaration of a global emergency, captures this. Laboratory close-ups of mosquito pupae being inoculated with Wolbachia are interspersed with images of Zika babies who are no longer babies but rather seven-year-old children requiring many different forms of care and images of deforested cliffsides cloaked in plastic tarps after extreme rains and a contaminated drinking water reservoir.[86] Silicon Valley's optimism about reproduction, its ineluctable grounding in the labor of care even as systems of care are eviscerated, its imbrication with the lived local effects of the Anthropocene: All of these are represented in Galdieri's depictions. I see them together as part of the same world-making process.

The answers also require connecting the dots between evolutionary thought, the technical solutionism of philanthrocapitalists, and eugenics, as I have started to do here. As Stepan vitally asserts, blanket criticisms of disease eradication are "a form of resignation to, or acceptance of, diseases in poor countries that would not be tolerated in rich ones."[87] Surely this is also the case for the idea of mosquito eradication, and I am conscious that my wariness about it here could be read as falling into the resignation of which Stepan warns. To avoid any doubt: The Oxitec and Wolbachia experiments in Brazil largely worked and were for the most part well received by members of the communities in which they were carried out. For those living with the reality of dangerous mosquito-borne illnesses, and who under other circumstances might have been subjected to chemical spraying as a way to control the mosquitoes that carry them, the large-scale deployment of modified mosquitoes could be a blessing. (And while I am skeptical of transhistorical claims about human nature, I think it is fair to say that nobody likes mosquitoes.) Yet to me it seems immensely important to be able to reflect on the historical significance of these projects, and to carefully consider the logics that run through them, precede them, and exceed them. In doing so, we see that the engineering of insect populations excavates early twentieth-century thought on extinction and eugenics and repurposes it for the twenty-first century, elaborating on an emergent global Anthropocene imagination in which decisions about worth for reproduction play a fundamental role, conveniently reducing the frame of the environmental crisis to one of reproductivity. It is to the main contours of that thickening view of reproduction to which I turn in closing.

EPILOGUE
Love Without Romance

We live in a time of abundant reproductive uncertainty. Advances in genetic engineering and fertility science have spiraled reproduction out and away from the sexed female body, while family planning programs targeting massed groups of women and girls living outside the overdeveloped world proliferate. Apprehensions about overpopulation, sterility, and demographic decline abound and interact with one another. Apocalyptic imaginations of humans becoming extinct pile up in the middle of the sixth great extinction, anthropogenic and ongoing. Fossil fuel companies, billionaires, and well-meaning liberals alike read environmental devastation as a problem of baby-making.

In this sea of uncertainty, a single genetic mutation, one swerve in the process of cell division that is routine in reproduction, suddenly became a global emergency of reproduction. Zika ignited fears over the precarity of human reproduction in the face of what is, and what is imagined to be, environmental upheaval from many different angles. From evolutionary processes unfolding over millions of years and at the breakneck speed of novel viral mutations, a new confluence of human, mosquito, and viral reproduction came into being. It was, and remains, one expression of the broad planetary inter-

dependency of reproduction that we must come to grips with as the planet heats up.

But familiar asymmetries of reproductive condemnation and encroachment were not far behind the recognition of that confluence. They recuperated modern reproductive thought from the early twentieth century and repurposed it for uncertain climatic and technoscientific futures. An image of a perfect child was elevated, the child whose future stood as a rejoinder to the errant nonhuman hyperfertility and inhuman chemical signatures of the Anthropocene, and in opposition to the costly, racialized children with microcephaly whose numbers were growing in Brazil, Colombia, Central America, and the Caribbean. Investment in this notional child can be read as one attempt among many to reinscribe certainty and control into human genealogy in a moment when threats to that genealogy continue to accrue on a planetary scale. But crucially—more immediately and more concretely—the public and medical culture of Zika keyed into and augmented what I see as one of environmental breakdown's central developing biopolitics: the pitting of possible future lives against each other amid produced scarcity of safe ecological space and economic investment.

Over the course of just a few years, this biopolitics was actualized in a range of chemical, mechanical, hormonal, and genetic Zika interventions into reproductive bodies, lives, and processes. Some women and girls were positioned as the threshold between the emergency's dangerous viral and mosquito reproductive surfeit and potential children—and the potential futures those children portended. Consequently, in Puerto Rico, we learned that the sexed female body was the privileged point of intervention. Women and girls there were made responsible for that surfeit and issued chemicalized threats by the US government. They were offered and fitted with contraceptive implants on the basis of the values assigned to their potential children by various economic models and equations. Their reproductive freedoms were constricted in both obvious and subtle ways, in the context of climate upheaval and abandoned infrastructures for social reproduction, a context so often obscured in myopic takes on reproductive health. And in Brazil, we discerned the idea, increasingly funded by philanthrocapitalists of all kinds, that both utopian and dystopian futures could be engendered by reproductive manipulation through cutting-edge innovations in genetic science, as opposed to funding local care infrastructures. Insect engineering projects courted deliberate extinction, padding and extending that proposition, fundamental in our historical moment and likely to become more prominent in the future, that the foreclosure of some lives is necessary for the flourishing of others.

* * *

What can we learn from this period of intense reproductive experimentation, which may prove to be a template for future courses of action? Which styles of intervention will be durable, and which will disappear?[1] Answering these questions requires, as a final port of call in this history of Zika, the recognition that the virus has not in fact vanished. It has continued to circulate, replicating iteratively in the bodies of mosquitoes and in people, and it has cropped up in other parts of the world, with recent outbreaks being reported in India and Angola, and a lineage in Thailand causing documented cases of microcephaly.[2] The effects of Zika's reproductive rate not being zero in these regions is yet unclear.

It is true that the scale-up from a microcephaly cluster in Brazil to a truly global reproductive pandemic, which was prefigured and prognosticated throughout the emergency, never came to be. The high rates of microcephaly first reported in 2015 and then registering across other parts of Latin America and the Caribbean in 2016 were not repeated. We don't know why such a distinct and devastating linkage was forged between infection in early pregnancy and fetal development during those years, nor whether this linkage will be reestablished in the future, but gradually concern over Zika faded away. So did funding. When it became clear that the various reproductive economic dystopias presaged in the United States would not be realized, the CDC pulled back financial support, while right-wing Brazilian President Jair Bolsonaro cut state funding for Zika and other scientific research soon after taking office in 2019. Any remaining attention, funds, and research personnel in global health agencies were unsurprisingly diverted to the COVID-19 pandemic in 2020. In the words of Diana Rojas Alvarez, who currently leads the WHO's Zika effort, "everything went quiet."[3]

Even as uncertainty about Zika's own reproductive futures (further mutations) and its effects on human life (the long-term effects of microcephaly) remains substantial, the virus fell out of global public consciousness. But the emergency itself—its crescendo and decline as a global cultural object; its channeling of funds and desires; its reproduction of expertise; its coalescing of the molecular, the metrological, and the meteorological; its setting into motion of physical interventions in the reproductive body; and its very real effects on fetal development—has left all sorts of traces.

Consider, for example, the extant fear in scientific discussions about the possibility of Zika "herd immunity," which casts the relative plummeting of Zika's reproductive rate in original hotspots as a cause of concern for people in temperate regions.[4] Was the reduction in cases in Latin America indicative

of widespread immunity in the tropics? If tropical people are now immune to the tropical virus, would that render other regions vulnerable to the virus, given that it can spread through sex in temperate regions even in the absence of tropical mosquitoes? Could the disease end up sparing human reproduction in the regions that were hit hard in 2015–16 by bestowing upon them herd immunity, only to wreak havoc on human reproduction in the overdeveloped world?

Consider also the winds and rains, ever more unpredictable, that track along modernity's histories of violence and serve as harbingers for unlivable futures in the tropics for all but the global elite. Despite major Zika interventions concluding when Hurricane Maria made landfall in September 2017, the virus's Caribbean biography did not end then. The storm fundamentally altered the shape of mosquito habitats and life cycles; new watery spaces for mosquito reproduction emerged as islands flooded. In the weeks after the storm surge in the city of Caguas, Puerto Rico, for example, containers and rubble of all kinds filled with water, from which abundant *Aedes* pupae emerged. The hurricane effectively doubled the population of sexually mature female *Aedes aegypti*.[5] Why Zika replication was not immediately detected in this population post-Maria remains a mystery, but the proliferating mosquito, which serves as host for many diseases, is testament to the close ties between climate turbulence and nonhuman reproduction that may again impinge on human health or reproduction in the future.

Consider, too, the lives that continue to be lived beyond the bounds of the emergency. At the Ventino Ventura Foundation, a charity health center in Recife, mothers in T-shirts bearing the phrase "Fight Like a Mother" push their children, who were born with microcephaly at the beginning of the emergency, in wheelchairs. These children have trouble seeing and hearing. Most cannot swallow. Their arms and legs are hampered by too much, overly contracted muscle, and their hip joints did not develop properly as their bodies grew: "They froze in motor and intellectual development at six months [of age]."[6] Now six or seven years old, and mostly relying on the limited care labor and facilities that charities can provide, they and their families are, in the words of one mother, "basically forgotten." In rural parts of the country, children with congenital Zika syndrome do not have any access to care outside the family structure. Like the people abandoned in chapter 3, such families persist in sustaining themselves as they cease to qualify as subjects for reproductive support and are thus denied or stripped of access to care.

And consider the cash and impetus that underpin post-emergency, residual desires to understand Zika. More than a decade after the emergency, there is an appetite for exploring why the vast majority of women in the Americas

who gave birth to the forgotten children, and those children themselves, are of Black or mixed descent. Why, it is being asked, did *Aedes* find those pregnant women to be more desirable meals? Why was the Zika virus more likely to replicate in their bodies? Zika infections were concentrated in the precarious and working-class zones of the cities that experienced outbreaks in 2015–16: Women in these areas were much more likely to have been bitten because their neighborhoods and homes, as chapter 2 illustrated, were also sites of *Aedes* breeding. The proximity of these mothers to the reproductive cycle of the mosquito, a consequence of being poor, explains the racial distribution of microcephaly cases. But, years on, other explanations are being sought. There is a push, for instance, for research into genetic predispositions to Zika or to Zika crossing the placenta; more specifically, for research into whether African or Indigenous ancestry plays a role in the skew of documented suffering.[7] This push is emblematic of the twenty-first-century reinscription of race by genetics, that science born in lockstep with the modern reproductive imagination in the early twentieth century, which crowds out funding for and findings on the social determinants of health.[8] In this sense it mirrors the logic of the mosquito genetic engineering projects jump-started by the Zika emergency, now physically instantiated in a new factory in Oxfordshire that aims to generate, and distribute globally, more than a billion altered mosquito eggs per week. The technoscientific search for truth in the gene and the materially and socially detached lab-based innovations that scratch the itch billionaires feel for life control and life extension sit within a broad defunding of local care-based institutions and a broad intensification of environmental crises that clip the futures of ordinary people. In land, in learning, and in lucre; in life, in labor, and in love, the emergency lives on.

* * *

In the preface I located the early stages of this book's gestation in my being drawn into the Zika emergency by its signs and signals. Warnings were everywhere in 2016, and I felt they were directed at me. The project's other bookend, aside from the decrescendo of its official biography as global catastrophe, was that I wrote a great deal of the manuscript while pregnant, completed the first full draft on my due date, and worked up the final version in the haze and muck of the first two years of infant care. I don't subscribe to the idea that this experience was a prerequisite for me to truly grasp the depth of the Zika problem, or that it would be or should be for anyone else. Nonetheless, both my gestational labor and the intransigent helplessness of the new human, a defining feature of our species, incubated further thoughts on the stakes of the

twin specters of eugenics and fascism that flicker in and out of the story told here. Reproduction, as Emma Heaney beautifully argues, organizes people's bodies, feelings, and lives in ways that are not identical, but are related—and fruitfully, valuably so.[9]

By virtue of their necessary biological dependence on adults, babies are particularly fertile figures through which recognition of common humanity can be established and elaborated. The idea is that love for the assailable child reaches across borders and boundaries of all kinds, striking everyone in the heart. But while Zika's lexicon of children's vulnerability may have been more humanizing than its invocation of a future of climate breakdown in which humanity is susceptible to all manner of catastrophic biological twisting and turning, it is clear that the child was not a singular figure. Distinctions were made when the stories of the first cluster of microcephaly were, as with the sudden imagination of war or disaster at home, turned inward. What was, and remains, a planetary case of human reproductive vulnerability to escalating harmful extra-human reproduction was scripted as one that could potentially affect some futures in the overdeveloped world. Unacknowledged eugenicist logics marked off deserving from undeserving children. Ultimately, not much was asked of the beholders of the emergency who stood outside the regions of active transmission or at a distance from those neighborhoods where mosquito reproduction was firmly entwined with everyday life. The same was true of the social engineers who imagined futures and designed interventions for those areas according to the requisites of billionaire philanthrocapitalists. What kind of a world are we building if the dominant impulse following emergent dangerous environmental pressures is to pit children against one another in a new rendition of the struggle for existence before they are even born?

And it is clear that some women in some places were cruelly marked as objects-to-be-managed by virtue of their proximity to those children engaged in struggle. Climate breakdown has heightened the surveillance and regulation of sexed female bodies more than it has expanded reproductive autonomy; their conduct and social location are increasingly blamed for the effects of the Anthropocene's reproductive proliferations. The gendered politics of responsibility and respectability are never far away when populations are positioned as the single hinge between the dense, errant, and dangerous agency of the Earth and the future.

I opened by asking what reproduction will look like as the world heats up, and I think I have provided some suggestions here. I also asked what it *should* look like, and that question, I fear, has been left unanswered. But to hazard a response by way of conclusion, I have to guess it will have to do with the labors

of life and love that sit outside the tidy tales of romance we have encountered. Despite their relentless reduction to reproductive vectors, the people forcibly included in the web of interventions I explored have other ideas. Interrupting the image of the vector, Sophie Lewis has reframed reproduction—not just childbirth—as labor. In doing so, she positions the gestating body as a worker in dangerous conditions, who may refuse gestational labor as a kind of strike, or take it on as a means of engaging in political struggle.[10] Examples of this decision-making in the history of modernity abound. Women engaged in abortion and infanticide to resist the transition from feudalism to capitalism in Europe.[11] Enslaved women utilized plant knowledge "to abort offspring who would otherwise be born into bondage."[12] And in many different contexts, people have carried on with gestational labor when social engineers subtly or overtly sought to avert the births of their children. Such efforts expose the follies of isolating the reproductive body from those myriad forms of human labor that support embodied social life, as if the uterus were the only site of life- or love-building. Those who creatively contested Zika interventions join in this genealogy, refusing the reduction of their humanity and their relationships with others to the single characteristic of reproductivity. They are our guides in charting a future course for reproduction in the direction of true human mutuality—a requirement, I am convinced, for contending with, and living together within, environmental breakdowns both planetary and profoundly unequal.

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PREFACE

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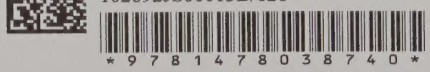

GEOGRAPHY / SCIENCE STUDIES

LOVE IN THE TIME OF ZIKA examines the transformation of reproductive politics spurred by the Zika public health emergency in 2016. Zika, a mosquito-borne disease with a direct effect on fetal development and children's abilities, provoked the surveillance of and intervention into women's and girls' bodies and lives. Paige Marie Patchin tracks this period of intense reproductive experimentation, from contraceptive implant insertion drives in Puerto Rico to the genetic modification of mosquitoes in Brazil, to explore the future of reproduction as environmental crises mount, public infrastructures wilt, and walls rise. Patchin questions what kind of a world we are building if the response to dangerous global environmental problems like Zika is to pit fetuses against one another in a future of limited resources. Set between the twin specters of eugenics and fascism, *Love in the Time of Zika* argues for the relevance of reproduction to wider questions about what it means to be people living among other people, and people living among other beings.

"*Love in the Time of Zika* reaches for optimism and produces ambiguity even as it tells a devastating story about how a host of political actors conspired to produce a future in which Puerto Rican and Brazilian visions of economic, political, and biological democracy do not matter."—**Laura Briggs**, author of *Reproducing Empire: Race, Sex, Science, and U.S. Imperialism in Puerto Rico*

"*Love in the Time of Zika* is about a period of intensive reproductive experimentation in a time of great environmental uncertainty. Patchin puts in sharp relief the immense stakes of this reproductive imaginary, in which many lives—human and not—are sacrificed to protect those deemed more deserving."—**Becky Mansfield**, Professor of Geography, The Ohio State University

Paige Marie Patchin is Lecturer in Race, Ethnicity and Postcolonial Studies at the Sarah Parker Remond Centre at University College London.

Cover art: A health worker sprays anti-mosquito chemicals in Brasilia, Brazil, 2020. Credit: Lucio Tavora/Xinhua/Alamy Live News.

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